The Dock & Harbour Authority

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The Dock & Harbour Authority

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Editorial Comments

The Port of Londonderry.

The article on this famous port we are privileged to publish in this issue has particular interest for two reasons, firstly, the historical side, and secondly, the changeover from the largest naval base on the western ocean to a peace time commercial port. The abstracts from the Londonderry Ordnance Survey report of 1837 show the keen spirit of the elected commissioners to handle the well-being of the port for the benefit of the local community as well as to provide inducements to shipping interests to use the port. It shows also the conflicts between the direct local authority and the distant all-powerful officialdom, the one anxious to secure economical and efficient service, and the other apparently apathetic to all the regional pleas until forced by political pressure. The report is concise and couched in attractive phraseology that demonstrates clearly how traditions, prestige, and customs of a port grow.

With regard to this latter point, Sir John Fisher, in his presidential address to the Baltic and International Maritime Conference at the Hague (1953) speaking generally, said: " There are many examples of port authorities and local chambers of Commerce holding to customs which have little to do with the actual and correct procedure of a particular trade " and " one would have thought that . . . the outmoded terms of the local Chambers of Commerce would have been modernised, but so far there has been no move in this direction."

So history repeats itself, and exemplifies how prone is mankind to cling to the proven experience of the past and how adverse he is to sudden changes.

However, in the case of the Port of Londonderry and its change-over to a full commercial port after eleven years of naval control, the traffic return figures show substantial gains, and the current expansion programmes demonstrate that the Londonderry Commissioners are alive to the needs of modern merchant sea traffic in the provision, on a competitive basis, of new equipment for the port.

New Chairman of British Transport Commission.

Until an official announcement could be made about the appointment of Chairman of the British Transport Commission, there seemed no possibility of any clarification about future plans for the nationalised transport system in Great Britain—railways, ports and inland waterways. It is therefore with great satisfaction that we welcome the appointment of General Sir Brian Robertson, who will shortly take up the responsibilities carried by Lord Hurcomb for the past five years. Lord Hurcomb had the task of inaugurating the new system of transport for Britain, in accord with the 1947 Transport Act; his task proved to be even more burdensome than could ever have been imagined, especially since political considerations so often impinged upon purely economic and commercial issues. Despite many difficulties, the period of Lord Hurcomb's term of office has been notable in many ways, and his influence will be felt for many years to come.

Sir Brian Robertson has a task of a different character, for he will take up his duties at the beginning of a period of readjustment, with increased decentralisation and, by the disposal of road haulage, abandonment of any attempt at a completely intergrated transport system. Sir Brian Robertson's record, both in military and commercial fields, will inspire confidence in his ability to overcome the many problems which must be faced.

Meanwhile, those concerned with ports and waterways await the announcement of appointments to the more broadly based Commission, in the belief that amongst them there will be men whose experience and judgment will promote efficiency and enterprise in these fields. The outstanding capacity of the new Chairman for the creation of an efficient administrative system, capable of rapid action, is likely to be of the greatest value.

Many important issues are still in abeyance, but with much of the frustration of uncertainty removed, substantial progress may be expected.

Problem of the Stowaway Immigrant.

In the forefront of every maritime conference there looms the unsolved problem of the stowaway and the obligations of the shipping company towards him, as laid down by the Merchant Shipping Act of 1884. Under Section 237, stowaways, when found aboard a vessel must be provided with food and a berth during the voyage. The captain and crew must treat them humanely and take no action which might involve hardship, such as an attempt to maroon them or to land them without money in a foreign country. In other words, these unwanted passengers become the responsibility of the shipowners, who must by law feed them en route, prosecute them on arrival for travelling without paying their fare; and if the magistrate decides they must be sent back, provide a passage back to the country of origin.

Here in Britain the problem is largely a matter of preventing British subjects from the West Indies, West Africa and Malta from sneaking a free passage aboard ships bound for the United Kingdom. There are, of course, foreign nationals but the number is negligible in comparison. A foreigner knows that he will probably make the journey in vain and all he will see of Britain will be a month in jail. On the other hand, to an unemployed coloured worker in one of the colonies, the chance is well worth taking; he has heard about full employment and social security in Britain and is fully prepared to serve a 28-day sentence if the magistrate is likely to exercise his prerogative and allow him to stay.

A few isolated cases of coloured workers stowing away on British ships might be tolerated by the companies as a trade risk, but in view of the increasing numbers now involved, it is felt with some justice that the existing legislation is hopelessly out-of-date. Originally it was intended as a humane measure to protect the odd adventurer from possible ill-usage in the days when rougher conditions prevailed at sea. The question of people being refused permission to land because of over-population was undreamed of. To-day stowaways rarely travel singly but generally in groups, and great ingenuity is exercised in hiding away until it is too late for the ship to put back to port. Often the captain has to call at an intermediate port or to alter his sailing schedule to put them off.

No wonder shipping companies are getting exasperated over this problem! The time and money lost, and the necessity for ceaseless vigilance at every port of call is too well known to need reiteration here. It may be worthwhile, however, to consider the various courses of action open to the Port and Shipping Industries. One proposal put forward was that an International Convention be

Editorial Comments—continued

established to lay down rules about the treatment of stowaways and their repatriation to the country of origin. Apart from the impracticability of such a proposal, it is of little use where the issue lies mainly between the United Kingdom and the Governments of the Colonies concerned. The latter are unlikely to be particularly worried about losing unemployed native workers or to be very anxious to repatriate them.

Another suggestion is that Section 237 of the Shipping Act of 1884 should be amended by Act of Parliament. It is difficult to see how the shipping companies or their servants can refuse to provide the necessities of life to penniless travellers however annoying they may be. The cost of transporting back the small minority that are refused permission to stay could perhaps be borne by the British taxpayer instead of the companies, but one can well imagine the protest such a proposal would raise if it were introduced into Parliament.

The average Englishman, who is the ultimate judge of any new legislation, has an instinctive sympathy for the underdog, particularly if he does not know the full facts of the case. The idea of a poor coloured man being sternly prosecuted by a shipping company to impose upon him a heavier sentence would be an anathema. There is also the possibility that whoever instituted a Bill on the subject would be accused of colour prejudice.

Meanwhile about 800 stowaways arrive at U.K. ports every year, and the number is increasing. Many are illiterate and quite unskilled, and automatically claim National Assistance; ultimately they may become a national problem to which the Government will have to give attention. There is no obvious remedy open to shipping interests, they can only patiently prepare the ground by telling the Press and the general public the full facts about the growing number of stowaways that has to be dealt with, and the ultimate effect on the national economy if the practice is allowed to continue indefinitely.

Timber Piles for Dock Engineering.

On a following page will be found a further instalment of the series of articles on Structural Timber for Dock Work. This is the last of the series and deals particularly with the structural merits of round timber piles as opposed to squared timber piles in port engineering works.

The precise reason for the departure from the use of whole tree piles for foundation work in the United Kingdom is not apparent, nor is it clear when the tendency to use square timbers first began to find favour. It is interesting to note, however, that up to the middle of the last century, round piles were used in concrete capped quay walls at Hamburg and possibly even later at Baltic and Scandinavian ports. The use of whole tree piles on the Continents of America and Australia has always been the rule from early colonising days, and generally speaking, continues to be the practice to-day.

The writer of the present article suggests that, in view of the growing scarcity of trees of a size large enough to provide square piles of long length and large girth, more consideration should be given in the United Kingdom to the use of round piles. This may be the more desirable, having regard to the possibility of providing in the future, from our own forests in Great Britain, round timbers of sizes suitable for piling.

There are, of course, many other kinds of timber which can and are now being used for large piles, but here again the use of round timbers would probably ease the supply situation to some extent. The subject is an interesting one in all its aspects, and is worthy of some consideration.

Topical Notes

Port Improvement Works for Jordan.

Major improvements for the Port of Aquaba — Jordan's only direct outlet to the sea — are nearing completion as the result of work begun last year by the Jordan Government on the recommendations of a port expert of the U.N. Technical Assistance Administration.

The port, which is situated in the south-western part of Jordan, was built during the war with limited facilities. Among the improvements now provided are a modern transit shed for the storage of ships' cargo, new mobile cranes for general cargo and the construction of a connecting road with the railway which runs to the northern, more populated and developed sections of the country.

Rhodesian Port Project.

The Congress of the Federation of Rhodesian Industries at Bulawayo recently passed a resolution urging the Federal Government to take steps to ensure the provision of territory in South-West Africa and Angola on which a new port and railway line could be built. A member of the executive of the Federation of Rhodesian Industries said in Salisbury recently that the apparently successful outcome of negotiations between the Portuguese and British Governments over Lake Nyasa might help negotiations concerning the acquisition of land in Angola, which is also Portuguese territory. An agreement has been reached between the British and Portuguese Governments under which the Nyasaland-Mozambique border has been altered so that the Portuguese own the eastern half of Lake Nyasa. A strong claim of the new Central African Federation to a port of its own is the fact that the three territories combined (making an area of slightly less than the Union of South Africa) is the largest country in the world under one administration which is without a seaport. Facts and figures about Tiger Bay and the possible route of the new railway line, prepared by a well-known Rhodesian surveyor, were quoted at the Federation congress. Through Tiger Bay the land and sea route to Southampton from a convenient point just south of the Victoria Falls would be 5,975 miles. This compares favourably with the Beira route (8,530 miles), the Lourenco Marques route (8,029 miles), and the Cape Town route (7,311 miles), the figures being based on the round-the-Cape route. The gradient on the proposed railway route is far lower than on any other of the existing or proposed routes, and so is the maximum altitude. Other points in favour of the Tiger Bay proposal are that it would bring the Rhodesias nearer the vital dollar markets; would be convenient for the export of Wankie coal, which may become increasingly available for export when the hydro-electric schemes go into operation; and it would not require a device such as an international corridor, because the land needed would be almost exactly on the Angola and South-West African border. Finally, surveys have shown the site to be admirably suited for a first-class port.

Tonnage Measurement for Swedish Ships.

The Swedish Board of Trade is now working out the details of the new tonnage-measurement organisation necessitated by the Swedish decision to adopt the so-called English tonnage-measurement system for ships. It is to come into effect on January 1st, 1955, and all Swedish vessels which do not already possess tonnage certificates under the new rules will have to be measured. It is calculated that the new system will involve a reduction of an average of 23 per cent. in the net tonnage, and that shipping dues will have to be increased by 30 per cent. to bring in the same revenue as hitherto. The tonnage-measuring organisation is also to be changed, with whole-time surveyors concentrated at Stockholm, Gothenburg and Malmo, and part-time surveyors at certain ports in Norrland and south-east Sweden. Some details of the system were given in this Journal in our issue for June last.

Port Development at Limerick.

Limerick Harbour Board has decided to raise loans amounting to £200,000 to cover part of the cost of the proposed port development scheme. The board will raise a loan of £100,000, while the Limerick Corporation, Limerick County Council and North Tipperary have agreed to guarantee the raising of an additional sum of £100,000. In addition to the loans proposed, the Government will give a grant of £150,000, plus a grant of £7,500 for the purchase of a dredger.

The Port of Londonderry

An Historic Harbour of Northern Ireland

(Specially Contributed)

ON the exposed coastline of North-West Ireland there lies Loch Foyle, a natural land locked harbour of considerable extent which for several centuries has provided refuge in peace and war to many North Atlantic voyagers. On its shores at the junction with the River Foyle there is the famed town of Derry which is more widely known as Londonderry. This new name came to it in 1600 A.D. on the occupation by English forces and the virtual adoption by the Corporation of the City of London. The town is known the world over for having given its name to an entrancing musical air but it also has claims to fame as a harbour affording relief to war weary sailors, merchant and navy, who ceaselessly ploughed and swept the Western Approaches. There is something naturally attractive about this old port that appeals to the salty wayfarer; besides, its sea-faring history has many touches of a charming homeliness. The following extracts from Colonel Colby's* report gives as neat a picture, both instructive and interesting, of the humble beginnings of a famous and modern port as one may wish to see.

"The quays are commodious. The attention of the Irish Society was early directed to the establishment of a proper quay, or wharf—as appears from the 29th item of their Instructions, issued to P. Probie, and M. Springham, Esqrs., on their visit of inspection in 1615:—'Item—whereas it hath beene propounded for the building of a key and a wharfe at the Derry, as a worke very necessarie and commodious to the towne both by enlarging of the customes and traffique there, we praie you to hearken to such sufficient men as will undertake it, and upon such good condicions as you shall finde reasonable and convenient for the good of the towne, and proffitt of the Society.' Messrs. Probie and Springham did not, however, see any reason for an immediate expenditure towards that object—reporting in 1616:—'There is a kaie as yet sufficient for that trade at Derrie, and hereafter when the fortification is finished the citie may either enlarge the same or make a new as they shall think fitting.'

"In 1624, the lords of the privy council called the attention of the city of London to various defects in the plantation of Ulster, with a view to their remedy or removal. Amongst others it was stated:—'There is a key now made along the ryver, of earth and faggotts, subject to contynuall decaye, by reason of the weakness of the materialls, and contynuall beatinge of the sea upon it; this key must be firmely made upp of stone, for the ornament, strength and commoditye of the citye': and again, more explicitly, in 1625:—'They are to make a strong and fair key of lime and stone, or of timber, which, besides the safety of shipping, will be an ornament to the citye and bring profitt with it.' To the necessity of undertaking such a work the city did not assent, their reply stating the sufficiency of the then existing quay:—'Touching the key, which is now of earth and faggots, and requires to be made of stone, they have alreadie bin at greate charge therewith, and are informed by their workmen that it is sufficyent; and they have lately let it to a new tenant, who is bound to keep it in good repaire.—And they will be carefull to see it soe kept that it shall be serviceable.'

"In 1629 the sum of £170 had been already disbursed by the Londoners for building several small quays. Among these was the Faggot-quay, which is the only semblance of a quay given in Raven's plan of Derry, in 1625, where it appears as a short mole.

"The growing trade of Derry must have soon required more extended accommodation than such a quay, or quays, could afford, and yet there is little recorded for many years of any additions having been made to it. In the Concise View of the Irish Society it is said that, on the 10th of November, 1732, 'Timber was ordered to be supplied for the repairs of the Ship Quay, Londonderry,' and it is therefore probable that a better description of quay had before that time been constructed. But such assistance was soon found insufficient, as in 1763, on the 2nd of November, the mayor, corporation, merchants and traders, petitioned the House for a grant 'to build a new pier, in addition to the present quay,' which petition was followed, on the 16th of the same month, by a resolution of the House, that the quay was insufficient for the increasing trade of the port. Again, in 1765, on the 11th of November, the mayor of Londonderry petitioned the House of Commons for aid to erect a pier; and again—in 1771, on the 19th of November—to complete the same, or quay. Between these two periods various sums were voted by Parliament towards this purpose, amounting in all to £4,590 15s.

"In 1790,—30 George III—the house of commons of Ireland in committee of supply, voted for improving the harbour and quays of the city of Derry, £300 a year for 21 years, which, however, by an act of the same date, was changed into a permanent duty, arising out of certain tonnage dues then granted, and considered equivalent to that sum. These dues were subsequently regulated by the act of 1835.

"Prior to 1832 the corporation alone possessed the right of having quays; they then lost their monopoly, and private ones were built. In addition to the above sum of £4,590 15s., granted at different periods by the Irish parliament, the corporation expended £12,588 on the quays; however, in November, 1831, they sold their interest in them for £5,000 to Mr. John A. Smyth, in whom their power became consequently vested. These quays are called the Merchants; or Custom-house, Quays; there are also 21 Sufferance, or Private Wharfs 2 at the Waterside included."

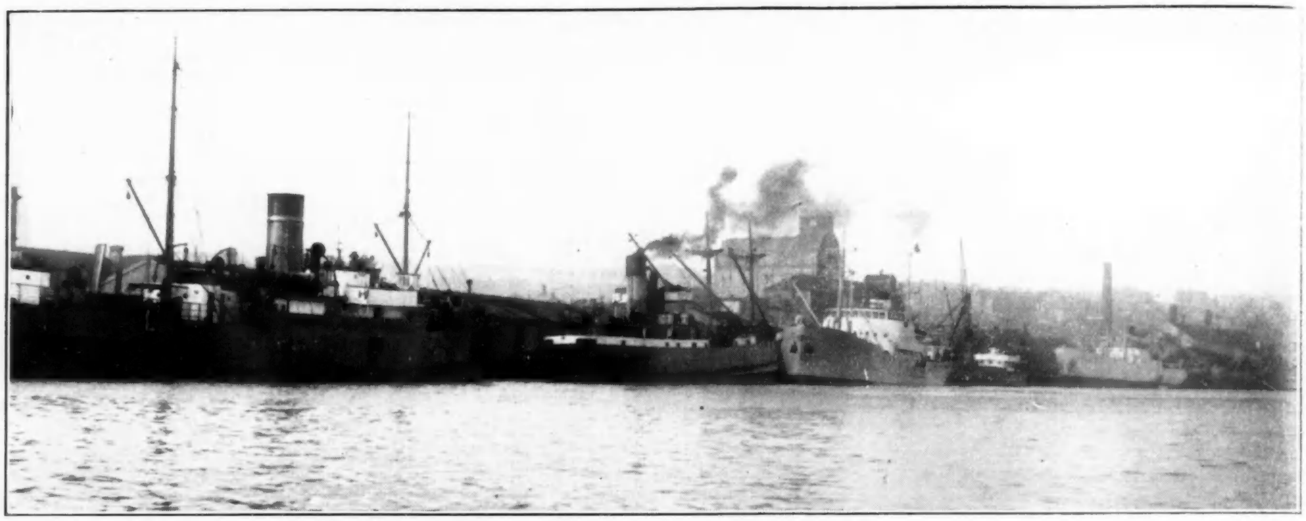
It is often advanced by the theorists that such and such regulation is old-fashioned or stupid and hampers progress, little appreciating the work and long experience of generations of their predecessors in hammering out the rule. There was no lack of clear thinking nor indeed short-sightedness in these old commissioners but there was a great understanding of human kind. The following extracts give excellent examples of the steady growth of port regulations to meet the several changes, or differences, of man's behaviour. These also are from Colonel Colby's report in 1837.

"The success of commercial speculations depends so much on the regularity and order with which they are conducted that, to ensure the prosperity of an extensive port, it is essential that arrangements should be made for promoting expedition and certainty in all its operations—for guarding, as far as practicable, against accidents to ships—and for facilitating their repairs. A well-matured system, therefore, of pilots, quays and docks, is of the highest importance, and the imposts for their support are at once reasonable and necessary. All the accommodations of this nature, which now exist, have of course been created subsequently to the occupation by the English, in 1600. Docwra, with his little armament, ran twice aground on the shallows, which encumber the lough and finally marched to Derry, having landed at Culmore. The erection of the Faggot Quay is the earliest notice of attention to the commerce of the port.

"It must at first sight appear remarkable that the delegates of the London merchants, coming as they did from a city of commercial enterprise and wealth, should not have remedied these evils, and by adopting an enlightened system of Port Regulations and Police, have assisted in maturing the natural advantages of the harbour. Such would doubtless be the case were a similar undertaking to be now entered on by the London merchants: but, at that early period in the history of British Commerce, when the foundation of the mercantile wealth and influence of London was alone laid, it would not be expected that the money, the talents, and the energies of its merchants should be diverted from the animating pursuit of newly-projected and grand schemes of Foreign Commerce to the comparatively humble object of fostering a remote, and new-born settlement. It was more reasonable to suppose that the Londoners would look to their newly-acquired property as a source of revenue in aid of their commercial projects; and to the influence, therefore, of such circumstances may probably be ascribed the almost total neglect of the port and harbour, as well as the feeble

*"Ordnance Survey of the County of Londonderry" 1837, Vol. 1 p. 118.

The Port of Londonderry—(*continued*)



Ships discharging and loading at Queen's Quay, Londonderry.

ness of the first efforts of the Londoners to develop the resources of the country. Left to be the result of growing internal wealth, the improvement of the port advanced but slowly; and a century appears to have passed away before any decided steps were taken to cleanse the channel of the harbour, and to establish a police for its regulation.

"Ballast Office.—The first notice of an institution, so essential to the well-being of an extensive port, occurs on the 17th of December, 1729, when the mayor, aldermen, and burgesses of the city of Londonderry petitioned parliament on their own behalf, and that of the merchants, for leave to introduce into a general act, then before the House, a clause for cleansing the channel, harbour, and river of the port of said city, and for erecting a Ballast Office therein: the petition was, however, afterwards withdrawn.

"On the 16th of February, 1778, the mayor, aldermen, and burgesses again petitioned for the appointment of an admiral and water-bailiffs, to regulate the herring fishery, and to check violence in the destruction of nets, buoys, etc. In this petition the advantage of the herring fishery, particularly in Lough Swilly, was strongly urged.

"In 1790, by 30 George III, power was given to quay-masters to make room for laden ships, coming into the harbour, by calling on the masters of those which had discharged their cargoes to remove from the quays, and, in case of refusal or neglect, by themselves removing the said ships or vessels 'to some convenient berth, near the place where such ship or ships, vessel or vessels, then lay, as they shall judge most proper': and, on complaint being made by the quay-masters of such neglect, the complaint being confirmed 'by oaths of one or more witness or witnesses,' the mayor was empowered to levy and recover such penalty or penalties as should seem fit, by distress and sale of the offender's goods and chattels.

"In 1800, by 40 George III, a further approximation was made to the form and powers of a Ballast Office. By that act the mayor, community and citizens, in common council assembled, were enjoined to elect and appoint, on the 2nd day of November annually, seven wholesale merchants, resident in the city of Londonderry, who were to appoint pilots, and make rules and orders for the regulation of their conduct, and of the charges to be paid to them, as recompense, by the masters and owners of vessels. The Committee were, however, required to notify each appointment to the mayor, whose duty it was to issue to the pilot the necessary licence, and to take security for the faithful discharge of his duty.

"On the 23rd of June, 1808, by 48 George III, this Committee was extended, and endowed with fuller powers. It was enacted that the mayor, community, and citizens, in common council assembled, should, as before, on the 2nd of November annually, elect and appoint seven wholesale merchants, who, together with the members of parliament for the city and for the county of Londonderry, for the time being, and the collector of customs of the said city, should constitute and be called The Ballast Office Committee for the Lough and River, Port and Harbour, of Lough Foyle, with powers to carry into effect the provisions of 40 George III, and further to make such bylaws and orders as were necessary to ensure the improvement of the harbour and port, and the erection therein of proper buoys and marks—as well as for the regulation of the conduct of pilots, bargemen, seamen, etc., the licensing and registering of boats, barges, lighters, and other vessels—and the determination of the rates of pilotage.

"By this act all vessels, boats, etc., navigating Lough Foyle were required to take out a license under the hand and seal of the mayor, who was enjoined to issue such license on a certificate from the Ballast Office Committee, or their secretary, that the license duty, not in any case exceeding £2, had been paid. The Committee had also the power of levying certain tonnage duties specified by the act. The penalty for breach of the rules, by-laws, and orders of the Committee was by the act not to exceed £20 on any one person for any one offence.

"In July, 1832, by 2 and 3 William IV (Local and Personal), the 48 George III was repealed, and the Committee was remodelled. By that act the Port Regulations are under the control of a Committee of this establishment, which consists of the mayor for the time being, and seven other members, three of whom form a quorum. The two senior members go out by rotation, annually. Candidates must be occupants of premises within three miles of the Corporation Hall, rated at £30 to the annual applotment of the Police Committee, and must also have been shareholders to the amount of £250 in shipping registered from the port, or have, in lieu of the latter qualification, imported or exported goods of the value of £2,000, or paid in freight £200, during the year preceding the election. Electors must be occupants of premises similarly situated, and rated at £10, and must also have been shareholders to the amount of £100, during the six months previous to the election, or have imported or exported within the year goods of the value of £500, or paid in freight £50.

"The power of fine for breach of the by-laws was reduced to forty shillings on any one person for any one offence; but, at the same time, several distinct fines were by the act attached to particular offences, as will be specified.

"Docks.—The complaints urged against the corporation, for neglecting to apply some portion of the tonnage dues to the establishment of Docks, has already been noticed; it is, however, doubtful whether any probable saving effected on these funds would have been adequate to such an object. That the Irish Society should have overlooked them is more surprising; but even now it is not too late to supply the deficiency, by applying a portion of its revenue to this purpose. If for instance, the proposed inclosure of the Slob were to be undertaken by the Society itself, and combined with the formation of Docks, an immediate benefit would be conferred on the

The Port of Londonderry—continued

port, and an ultimate equivalent return secured to the Society.

"Until about six years ago there was no accommodation for repairing vessels, except by laying them on the bank of the river, or excavating for them in shallow docks, or cuts, in the Slob—a system which, in spite of its difficulties with so small a fall of tide, is still sometimes followed; most vessels, however, were sent to Liverpool, or the Clyde, when in need of repair.

"In 1830 Messrs. Pitt Skipton & Co. undertook to construct a Patent Slip Dock, where vessels of 300 tons' register can now be hove out of the water and repaired. The expense was £4,000. In 1834 there were 31 vessels of all sizes repaired at the Slip. In 1835 there were 13 repaired, and about 20 open boats; of the vessels three were put on the Slip, and 10 into the Dock. In 1836 there were nine vessels repaired (including two steam-packets), and about 20 open boats: of the vessels six were put on the Slip and three into the Dock. The Slip is found to answer all the purposes of a dry dock.

Mr. Skipton's partner is Mr. Henderson, an experienced lieutenant in the navy. A first-rate foreman, and a gang of good shipwrights, are employed in the general yard, attached to the establishment, from which a vessel of 180 tons' register has been launched: it is a handsome vessel, built of Irish oak, and calculated to carry 259 tons.

"Naval stores are imported from Liverpool and Glasgow. Sails are made on the spot. Both American and Baltic pine are extensively imported. The oak used is chiefly Irish, and procured from Walworth Wood, Killymoon, Learmount, etc. Small vessels, when outward bound, water at the wharfs, but large vessels at Moville, to ensure a light draft in crossing the flats, which lie between it and Derry."

The Modern Port.

Londonderry is the only port of importance on the North-West coast of Ireland and is situated at the head of the magnificent Lough Foyle, a sheet of land locked water shaped like a pear about 24 miles long, seven miles wide near its head and only $2\frac{1}{2}$ miles wide near Innishowen Head which marks the entrance. It forms an excellent harbour of refuge, accessible in all weathers excepting, of course, during dense fog which, fortunately, occurs but seldom. The minimum depth of water in the roadstead opposite Moville of 50-ft. at low water ordinary spring tides encouraged western ocean liners of pre-war days to make Lough Foyle a port of call to pick up or disembark mail and passengers. The great development of air services has now affected this traffic, in common with many other similarly situated world ports. The channel from Moville to Derry, a distance of about 20 miles, has been well marked with navigational aids—buoys and lights. Most of the lights are automatic acetylene gas tracing the deep channel throughout its entire length to the port. The Harbour Commissioners deepened the channel in the years 1938-39 to a minimum of 20-ft. at low water ordinary spring tides and as the tidal range is 5—6-ft. at neaps and 8-ft. ordinary springs, ships drawing up to 23-ft. 6-in. can be safely navigated to the port for the greater part of the flood duration.

Port Organisation.

The Londonderry Port and Harbour Commissioners were constituted as a Port Authority by various Acts of Parliament dating from 1854, and consists of 15 elected members, a representative of the Londonderry Corporation and the Mayor of the City for the time being. The principal officers are: Secretary, Engineer, Harbour Master, Accountant and Cashier. The pilots are under the control of the Commissioners as the Pilotage Authority for the Londonderry Pilotage District. There are two pilot stations, one at Innishowen Head at the entrance to Lough Foyle for inward bound vessels, and the other at Derry for outward bound ships. The Harbour Police are also under the control of the Commissioners.

Limits of the Port.

The limits of the port so far as the jurisdiction of the Commissioners over the same is concerned with respect to conservancy and rates, extends from Lifford Bridge to a line drawn from Greencastle Fort in the County of Donegal to the Tower on Magilligan Point in the City and County of Londonderry.

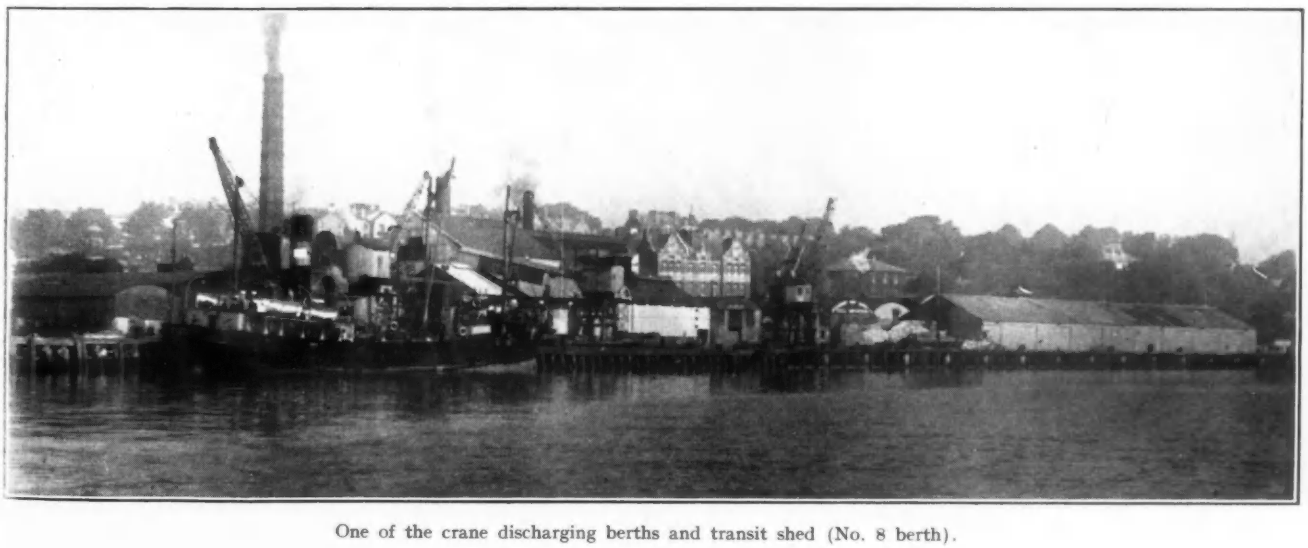
Port Facilities.

The equipment of the harbour is of an up-to-date character, adequate electric and steam cranes, ranging from two tons to 35 tons, being provided along the two miles of quays, and vessels are assured of quick dispatch. Commodious transit sheds are available for the reception of goods, and there is also extensive private warehouse accommodation in the rear of the quays. The quays are lighted by electricity, and in some of the transit sheds gas lights are provided.

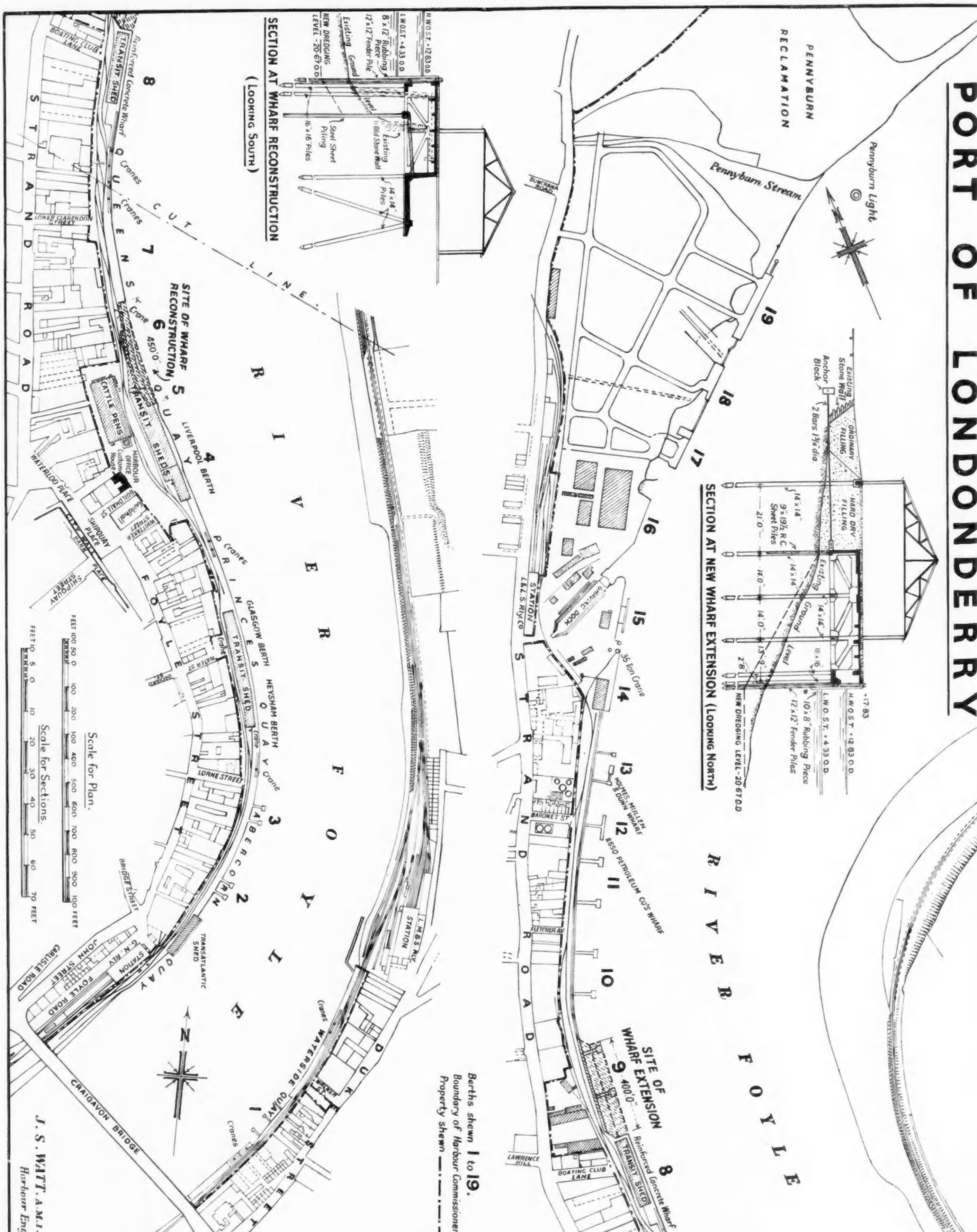
Owing to its geographical position, the port is the natural distributing centre for the whole of the north-west of Ireland. It is served by four railway systems—the Great Northern (I), the Ulster Transport Authority (broad gauge), the Donegal, and the Londonderry and Lough Swilly Railways (narrow gauge) — and these system are connected with all the other railways in Ireland. All the quays of the Harbour Commissioners are provided with railway lines which are linked up with the various railways.

On the Commissioners' quays there are six miles of track all "mixed gauge," so that traffic from the broad and narrow gauge systems can be operated simultaneously. The working of this system is unique, inasmuch as the trains operated over it are made up of broad and narrow gauge wagons. The railway lines on both sides of the river are connected by a subway underneath Craigavon Bridge.

The port is especially adapted for the shipment of live stock on a large scale. The pens for the reception of cattle, sheep and pigs for inspection by Government veterinary officers before shipment are situated close to the shipping berths, and are completely roofed over for the protection of the animals.



One of the crane discharging berths and transit shed (No. 8 berth).


PORT OF LONDONDERRY
PENNYBURN RECLAMATION
Pennyburn Stream
Pennyburn Light
SECTION AT NEW WHARF EXTENSION (LOOKING NORTH)
SECTION AT WHARF RECONSTRUCTION (LOOKING SOUTH)
RIVER FOYLE
CUT LINE
SITE OF WHARF RECONSTRUCTION 6 450'0"
SITE OF WHARF EXTENSION 9 400'0"
STRAND ROAD
QUEENS QUAY
PRINCES QUAY
ABERCORN QUAY
FOYLE STREET
DUKE STREET
WATERSIDE QUAY
CRAIGAVON BRIDGE
ESSO PETROLEUM CO'S WHARF
Scale for Plan.
Scale for Sections.
Berths shewn 1 to 19.
Boundary of Harbour Commissioners' Property shewn
J. S. WATT, A.M.I.C.E.
Harbour Engineer

The Port of Londonderry—continued

Imports and Exports.

The principal imports, foreign and coastwise, are ale, beer, etc., artificial manure and manure ingredients, building materials, cement, chemicals, coal, cocoa beans, cotton cloth, feeding stuffs, fuel oil, motor spirit, etc., iron and steel, grain, flour, etc., sugar, tar, timber, tinplate, Government stores. The chief exports consist of livestock, bacon and hams, burnt ore, cotton goods, condensed and powdered milk and milk foods, chocolate and chocolate compound, eggs, grain offals, canned fruit, hides and skins, scrap iron, potatoes, pit props and Government stores.

Trade of the Port of Londonderry.

The total net registered tonnage of vessels which entered the port for the year 1952 and 1951 was classified as follows:—

	1952 Net regd. tons.	1951 Net regd. tons.
Home Trade	375,408	397,662
Foreign Trade	17,910	40,413
Non-trading	634,779	439,008
Total	1,028,097	877,083

Tonnage of Goods Imported and Exported.

	1952 Tons	1951 Tons
Imports	358,765	387,637
Exports (excludes livestock shipments)	99,812	103,947
	458,577	491,584

Livestock Shipments to Cross-Channel Ports.

	1952 Number	1951 Number
Cattle	75,042	92,024
Sheep	59,248	30,802
Pigs	—	59
Horses	386	953
Total (all animals) ...	134,676	123,838

Londonderry as a Naval Base.

During the European War 1939-1945, the Port of Londonderry played a very important part in winning the "Battle of the Atlantic." In the summer of 1940 the Admiralty established a naval base at the port for the operation of Escort Groups. To provide for the berthage of the large number of warships using the port, a number of dolphins and jetties were constructed in the harbour. About 4½ miles downstream from Derry, wharfage covering about 4,000 lineal feet of waterfront was also erected. In the rear of this wharfage the United States Naval Authorities constructed an extensive oil installation, and oil tankers can be discharged at the wharf opposite thereto. During the war this oiling station was used extensively by warships for refuelling, and is still used by H.M. Ships of the Londonderry Training Flotilla. The old shipyard belonging to the Harbour Commissioners was converted by the United States Naval Authorities into a dockyard for the repair and maintenance of all naval vessels based on Londonderry, and an enormous amount of repair work and re-conditioning of ships was carried out there expeditiously and efficiently. The graving dock alongside the shipyard was also lengthened for the accommodation of large destroyers.

On the capitulation of Germany, a large number of U-boats—about 70 in all—were accommodated at this port. On the occasion of the surrender of the first batch of submarines, the Commander-in-Chief, Western Approaches, paid tribute to the Port of Londonderry for having been mainly instrumental in defeating the U-boats, and mentioned that Derry was the largest base used in the Battle of the Atlantic. A similar tribute was paid by the Commodore in command of the base upon relinquishing his command at the end of June, 1945, who also referred to the valuable work carried out in the repair and maintenance of naval craft based on the port.

Between June, 1940, and June, 1945, the tonnage of Admiralty, United States, Canadian, etc., naval ships entering the port totalled in round figures, five and a half million tons net register.

New Construction.

In order to provide additional shed accommodation the Harbour Commissioners have decided to proceed with a scheme for the extension of Queen's Quay Northwards. The wharf will be of reinforced concrete and will be 400-ft. long. It is proposed to erect a transit shed on the wharf, 300-ft. long by 50-ft. wide, and should give valuable space for cargoes for shipment to or from cross-channel or foreign ports. The wharf will be constructed on four rows of reinforced concrete piles, and the ground behind the wharf will be

Warships in Londonderry Harbour during the 1939-1945 War.

filled in to provide a width of roadway of 60-ft. The berth has already been dredged to give a depth of 25-ft. at L.W.O.S.T. alongside.

It is also proposed to reconstruct about 450-ft. of wharf at No. 6 Berth. At present this wharf is of timber with timber sheet piling along the front of it. When reconstructed, the new length of wharf will have steel piling at the back of the wharf, and the structure will be retained by raking reinforced concrete piles. The new wharf will be constructed on two rows of reinforced concrete piles, and will also have a depth of 25-ft. at L.W.O.S.T. alongside. Some difficulty was experienced in arriving at a suitable design owing to the presence of an old stone quay wall. It was found necessary to contain this wall by steel sheet piling as it was considered impracticable to remove it. The range of Transit Sheds at present on the site at Berth No. 6 will be dismantled and, on the completion of the wharf, will be re-erected

The contractors, Messrs. McLaughlin & Harvey, Ltd., have started work on the contract, which it is hoped will be completed in about four years' time The work will be carried out under the supervision of the Harbour Engineer, Mr. J. S. Watt, M.B.E., A.M.I.C.E., in collaboration with the Consulting Engineers, L. G. Mouchel & Partners, Ltd. The total cost of the improvements in hand will be over £250,000.

Our thanks are due to the Chairman of the Commissioners, Col. Sir Basil McFarland, and to Mr. B. R. Douglass, Secretary, and Capt. R. C. Macauley, M.B.E., Harbour Master, for the information given in this article.

Progress Report of Cargo Handling Association.

According to a report recently issued by the International Cargo Handling Co-ordination Association, membership has increased in Europe, Africa, India and the Far East. A United States National Committee has also been inaugurated, supported by the Port of New York and other U.S. interests. The total number of port members throughout the world now exceeds 50.

Marine Drilling for Oil

Undersea Exploration off Borneo

The British Malayan Petroleum Company have for some time been considering semi-exploration work to test for a possible extension of their oilfield below the sea adjacent to their present workings. In this connection a British Civil Engineering Contracting Company was recently associated with them in the construction of a marine drilling platform.*

The platform, which carries a total load of 1,700 tons, is approximately 100-ft. x 50-ft., with a deck level 20-ft. above the sea. The sea at this point, which is a mile off-shore, is just under 30-ft. deep and the platform was designed to be carried on 28 steel piles. In addition to the drilling platform, six smaller ones, each 27-ft. x 17-ft., were constructed to carry an aerial ropeway between the drilling platform and the shore.

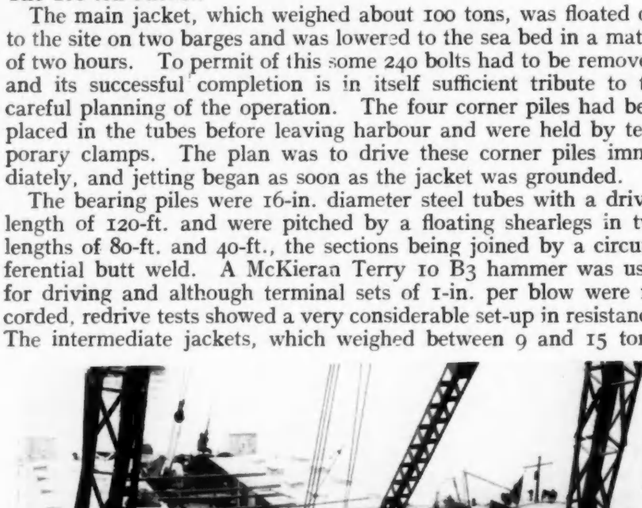
Pre-assembly.

Site conditions which limited the construction to the fair weather period, April to July, necessitated the maximum possible pre-assembly of the platforms in harbour. For the main platform a structure consisting of thirty-two steel tubes 24-in. in diameter and 37-ft. long, braced together by steel angles, was built up in the harbour so that it could be floated to sea and sunk at the proposed location. The steel tubes then served as guides through which the supporting piles could be driven, the space between the tube and the pile finally being grouted up to provide a firm system of underwater bracing. This frame was referred to as a jacket, and six smaller jackets, each using four tubes only, were constructed for the ropeway platforms.

The 100-ton Jacket.

The main jacket, which weighed about 100 tons, was floated out to the site on two barges and was lowered to the sea bed in a matter of two hours. To permit of this some 240 bolts had to be removed, and its successful completion is in itself sufficient tribute to the careful planning of the operation. The four corner piles had been placed in the tubes before leaving harbour and were held by temporary clamps. The plan was to drive these corner piles immediately, and jetting began as soon as the jacket was grounded.

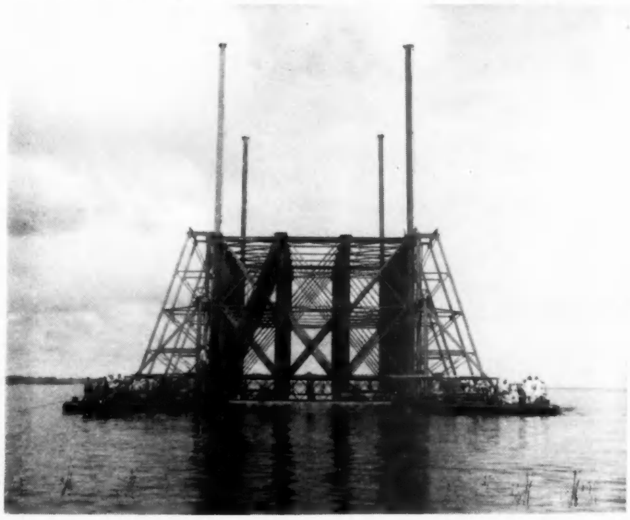
The bearing piles were 16-in. diameter steel tubes with a driven length of 120-ft. and were pitched by a floating shearlegs in two lengths of 80-ft. and 40-ft., the sections being joined by a circumferential butt weld. A McKieran Terry 10 B3 hammer was used for driving and although terminal sets of 1-in. per blow were recorded, redrive tests showed a very considerable set-up in resistance. The intermediate jackets, which weighed between 9 and 15 tons, were placed by similar means, the pile lengths varying between 80 and 130-ft. A 10-ft. high superstructure, which was added to the main jacket, was also pre-erected on shore in units of four columns with cross bracing, the boxes so formed being placed by crane. On top of this superstructure were placed the heavy beams of the derrick sub-structure designed to distribute the loads from the working derrick.



A general view of construction work in progress.

*See Dock and Harbour Authority, June 1949, for details of a drilling platform constructed in the Gulf of Mexico.

Maximum advantage was gained from the heights of spring tides.



A view of the platform, a mile off shore. Approximately 100-ft. by 50-ft. it is designed to carry a load of 1,700 tons.

The skyline trestles were formed of tubular steel members and were 66-ft. high. In some cases the bases of these trestles were 20-ft. above sea level and erection of the whole trestle provided a very difficult erection problem, very careful planning once again being necessary to ensure the maximum advantage was gained from the heights of spring tides. In spite of a delayed start and unexpectedly bad weather during the "fair-weather" period, the whole of the structural steelwork was completed in a total working period of seven months.

Designed at The Hague.

The bulk of the design was done in the offices of the Bataafsche Petroleum My, at The Hague. The Oil Company's Chief Engineer directed construction on the site with a Marine Superintendent in charge of all marine operations, while Messrs. Geo. Wimpey & Co., Ltd., were associated with the British Malayan Petroleum Company in the construction of the drilling platform. We are indebted to the British Malayan Petroleum Company together with their technical advisers, the Anglo-Saxon Petroleum Co., and Bataafsche Petroleum My. for permission to publish this article.

Harbour Scheme for Island of Stroma.

Work is to start immediately on Caithness County Council's £28,500 scheme for a harbour on the island of Stroma in the Pentland Firth. The Scottish Home Department have approved a grant of £22,800—80 per cent.—towards the cost of the scheme.

Harbour Fires from Floating Oil

An Account of some Australian Investigations

By R. P. DONNELLY, M.Inst.Fuel
Fuel Technologist, W. Australian Government.

Foreword.

The important problem of Fire Prevention was referred to in the Editorial columns of the July issue of this Journal.

The publication of "Fire Research, 1952," by H.M.S.O., London, was mentioned together with certain experiments which had been carried out by the Fire Research Station of the D.S.I.R.

The following article by a Fuel Technologist describing an investigation into the cause of a serious fire caused by oil ignition, is opportune and of considerable interest.

On the afternoon of the 17th January, 1945, a ship, *S.S. Panamanian* which was loading alongside a wharf in Fremantle, Harbour, Western Australia, caught fire. The fire was fortunately, through prompt action by the Port Authorities, confined to the ship itself, otherwise since munition ships were in the harbour and oil tankers were in the near vicinity of the wharf the fire could have assumed disastrous magnitude. As it was, the "Panamanian" burnt for three days and suffered damage and losses to ship and cargo which were estimated at £300,000 in a claim filed by the ship's owners against the harbour authorities.

The claim failed and some of the reasons for this are detailed in the investigation, an account of which is given here. The origin and nature of the fire is of interest since it gives some indication of the danger which could arise from oil accumulation in harbours and the possibility of setting these on fire even though the oil is of high flash point and relatively non-inflammable.

The immediate cause of the fire was a piece of smouldering burlap which measured 6-ft. x 8-ft. which had been bundled up and thrown overboard so as to fall between the ship and the timber of the adjacent wharf. Within half a minute of falling, the burlap blazed up and before two minutes, flames were leaping so fiercely between the side of the ship and the adjacent wharf that they both rapidly caught on fire. The wharf was wood and the side of the ship had accumulations of oil and thick, perhaps tarry, paint. The wharf burnt for a considerable distance and the fire spread from the side of the ship to the deck and cargo.

A theory advanced at the time for this rapid ignition was that as the afternoon of the 17th January was very hot (104° F. in the shade and 156° F. in the sun), vapour was distilled from oil films on the water under the wharf and that this flashed when the smouldering burlap fell down. This theory appears to be incorrect for a number of obvious reasons, but it was nevertheless advanced by witnesses on behalf of the owners of the ship. As diesel oil was present, from time to time from submarines using the harbour, as oil films of varying thickness, the blame could be laid on the oil from this source ignited by flash from the burlap.

The writer advanced an alternative explanation, which appears to be a more correct one, on the basis of experimental evidence detailed here. It was that the burlap acted as a wick which caused the ignition of a thick film (3/16-in.) alongside the ship. Internal evidence in the case also suggested that this oil could not have come from the submarines using the harbour, but may have come from other vessels burning heavier oil, which could include oil pumped from the bilges of the *Panamanian* on the morning of the fire.

The judgment in the case was that the Harbour Authorities and Commonwealth of Australia were not liable for the fire and the claims by the owners were dismissed. The account of the circumstances of the fire is of value to harbour authorities in defining risks from thick oil films and possible methods of ignition.

Ignition of Oil Films.

The ignition of thick (3/16-in.) oil films on water was investigated by the writer in 1933 in connection with the safety of the oil floating on the water in oil filmed gas holder lutes in gasworks. It was found that sparks, cigarette ends, lighted matches and such casual ways of possible ignition did not fire the oil even when it contained percentages of benzene which lowered its flash point to 110° F. and its fire point to 150° F., i.e. within the Board of Trade definition of inflammable liquids.

Such films could, however, be ignited by pieces of lighted paper floating in the surface or better by burning fabric. Observations of the growth of such ignition showed that the paper or fabric first acted as a wick which drew up oil to its own fire and thus fed it into a sufficiently fierce blaze to heat the adjacent parts of the oil film to a temperature above the fire point of the oil. When this condition was reached, the flame jumped across from the wick to the oil surface and immediately set fire to the vapour coming off from the oil. Thereafter the flame spread rapidly over the whole oil surface and produced a fierce conflagration of upward swirling flames characteristic of oil fires. The conflagration continued fiercely for 3—5 minutes until the film was almost burnt out and then died out fairly quickly.

This research work was taken up again when an investigation of the *Panamanian's* fire was required. For this purpose oil was filmed out on water contained in a trough 6-ft. long by 21-in. wide to a thickness of 3/16-in. Actually 0.9 gallons of oil was used giving an exact thickness of 0.168-in. Small pieces of hessian 9-in. x 18-in. were used as wicks supported so that they were half in and half out of the oil film. Experiments detailed in Table 1 showed that the oil took between 30 seconds and three minutes to ignite according to the type of oil; diesel oils with flash points under 200° F. lighting much more readily than heavy fuel oil. The time for the oil fire to establish itself over the full surface of the trough was correspondingly shorter for the lighter oils.

The *Panamanian* on fire in Fremantle Harbour—17th January 1947.

Ignition of Heavy Fuel Oil.

The actual ignition phenomenon of the *Panamanian's* fire had taken place over a short period of two minutes from first throwing overboard of the smouldering burlap to full fire leaping up the side of the ship, there was also evidence that the oil associated with the fire may have been heavy fuel oil. Means were, therefore, sought to secure rapid ignition of heavy oil by using larger pieces of hessian and burlap about 2-ft. square draped on a wooden frame into the oil. By this method rapid ignition of the oil was secured within periods of about two minutes from first ignition of the burlap to full ignition of the oil. The spread of the fire is shown in the two photographs, while the whole tank caught fire with flames 6-ft. high in about three minutes, fierce burning continuing until the oil film had almost burnt out. The conclusion reached was that large pieces of burlap as thrown overboard from the *S.S. Panamanian* could ignite thick films of oil alongside the ship. An eye-witness account of the behaviour of the burlap shows that in falling it caught on the wharf timbers so as to trail into the water, supported half in and half out in blazing condition so that it was suitably positioned to act as a

Table 1.—Ignition of Fuel Oils on Water at 80°F.

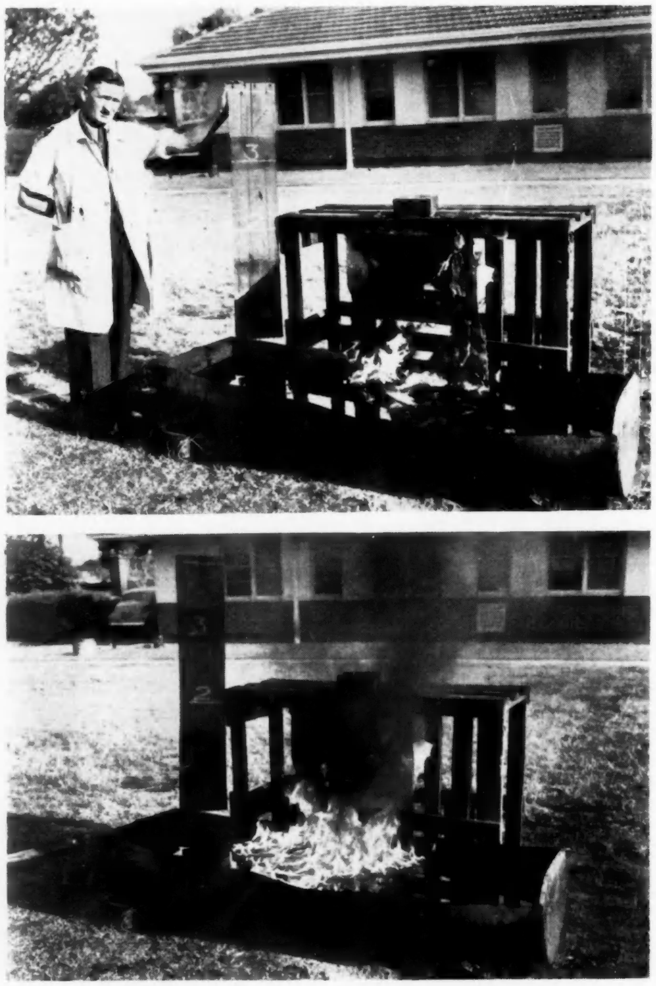
Oil	Closed Flash °F	Open Flash °F	Flame Point °F	Time to ignite film	Time for fire over whole tank
Marine Diesel	166	205	208	30 sec.	1 min.
Diesel Fuel	176	211	224	30 sec.	2½ min.
Diesoline	190	236	252	1½ sec.	3 min.
Fuel Oil	218	over 275	over 275	3 min.	5 min.

Harbour Fires from Floating Oil—*continued*

large and dangerous wick to set up a fire quite quickly over several square feet of oil film area.

Thickness of Oil Films.

It was a major point in examination of the ***Panamanian's*** fire to distinguish between the behaviour of films of diesel oil which would have come from submarines and fuel oil which would have come from the ***Panamanian*** herself. One piece of evidence which came immediately from pouring oil on to open water was that any degree of wave or popple on open water caused both light and heavy oils to thin out at once to a slick of oil of a completely unignitable character. Only under conditions of perfectly flat calm could films or layers of ignitable thickness be formed. Then, under the influence of surface tension forces, oils had characteristic and reproductable thicknesses. Characteristic thicknesses are given in Table 2.



Top. A piece of hessian hanging from a frame into the oil is begining to draw up oil to feed its flame by wick action.
Bottom. The flame has now left the wick and ignited oil vapour generated from the oil by the heat of the initial wick fed fire. The oil is now on fire and the flame is rapidly spreading to cover the whole surface only $1\frac{1}{2}$ minutes from setting fire to the hessian.

Table 2.—Oil Film Thicknesses on Water at 80°F.

Oil	Film Thickness Inches	Time of burn out minutes
Diesel Oil	0.08	1—$1\frac{1}{2}$
Fuel Oil	0.24	3—4
Lubricating Oil	0.36	5—6

From Table 2, two things are learnt. The first is that fuel oil films are a greater fire hazard than diesel oil films because they will burn longer and more fiercely than films resulting from spillage of lighter oils.

The other point related solely to evidence in the dispute. Since oil films have characteristic maximum thicknesses it is possible to calculate the maximum gallonage of any oil filmed over a given area of water surface. It was suggested in the action that diesel oil spillage was general over an area under the wharf of 400,000 sq. ft. At an oil thickness of 0.03-in. this suggested a volume of oil of 16,600 gallons which was too great a quantity to have come from and accumulated from casual spillage of oil in refuelling submarines particularly as there were standing precautions to reduce spillage. The alternative suggestion was that the *S.S. Panamanian* had put out oil on the morning of the fire in pumping her bilges over a limited area of water around her own hull, and this had combined with oil from other sources. Thus 60 gallons of oil would have covered 500 square feet of water with fuel oil 0.24-in. thick. There was evidence that there was a patch of oil around the ***Panamanian*** which tailed off into a streak of brown water. The conditions of the day were still and the tide was slack and this patch of oil associated with what could have been bilge water floating on the surface of the harbour would accord with bilge pumping when water would come first and oil afterwards if pumping were allowed to continue through an oversight so that the bilges were run so low that oil was pumped.

The foregoing evidence was useful in reaching a decision in the case, the outcome of which was that the plaintiff's claim was evidently dismissed more or less on the grounds that the plaintiff had failed to prove that the fire was caused by the defendant's negligence.

Scientific Interest.

There are two points of theoretical interest arising from this investigation. The first is an explanation of the relative ease of lighting oil lying on water. In Table 3 temperatures are tabulated against a vertical height in an oil film from which it is seen that there is a very sharp contrast of temperature across the burning film. For a film 3/16-in. thick the surface temperature is shown to be 200° C., while the surface in contact with the underlying water is at almost the temperature of the underlying water. The explanation of this is the familiar one that liquids are bad conductors when heated from the surface so that convective heat transfer is eliminated. The actual thermal conductivity of oil is 3.0×10^{-4} as compared with 6.0×10^{-4} for asbestos, i.e. undisturbed by convective forces it can be classed as an insulator.

Table 3.—Temperatures in a Film of Burning Oil

Surface	410°F	Oil water interface	68°F
3/16-in. down	95°F	Water temperature	59°F
3/8-in. down	72°F		

The remaining point relates to the coherence of oil in the form of thick layers. It can be shown fairly readily that on perfectly clean water, oil slicks out to a layer of molecular thickness. It is only when the water surface is contaminated by surface active agents that it is possible for thick layers to be formed. Such surface active agents will be present in adequate quantities in the waters of a harbour or in water from the bilges of a ship. Furthermore, if the behaviour of oil when poured on to water is observed, it is seen that the first drops of oil to touch the surface of water slick out to form an iridescent film. Thereafter further oil coheres and forms films of characteristic thickness. To some extent, therefore, any oil is self contaminating as regards oil water interfaces.

Under practical conditions, oil escaping from a ship into the sheltered water between ship and wharf may accumulate undisturbed and form a thick film of oil which will constitute a fire hazard. The ***Panamanian*** seems to have been the victim of precisely such conditions.

New Manager for Port of Belfast.

Mr. F. W. P. Hampton was recently appointed manager and secretary of the Belfast Harbour Commissioners. He entered the service of the Commissioners in 1914, being appointed chief committee clerk in 1942, and chief assistant to the general manager and secretary in 1946. He is a member of the Institute of Transport, the Belfast Transport Officials' Club and the Belfast Master Mariners' Club.

Structural Timber for Dock Work

Part VI. The Practical Usage of Square and Round Piles

By R. P. WOODS, B.A.For. (Cantab.)
Chief Scientific Officer, Timber Development Association.

A COMPARISON between American and English practice shows a strong bias in favour of round piles in the former country with the opposite in the latter. It is obvious that there are advantages and disadvantages with both methods, and it is proposed to discuss these various points in relation to timber usage.

As has been mentioned in previous articles, the shortage of long lengths of certain timbers, due to over-cutting and a continued high demand for certain species, has resulted in a scarcity, to a certain extent, of large dimensional timbers so frequently required for piling. If, however, long lengths in timber are essential, then these can be obtained from the Australian constructional timbers, or from other tropical sources.

On the other hand, a round pile is virtually the tree itself, and in mature trees is chiefly supplied by the Conifers, whereas hardwoods are at a younger age than those from which large squared piles are taken.

In reading literature, or annual reports of Forest Departments, or any regional botanical books, references are common to trees which grow to maximum height of 150—200-ft. or higher, with clear boles up to 60-ft. or more, but one must consider diameters in relation to these figures, and it frequently results in figures of 2-ft. and upwards. Such material is obviously unsuitable for piles without the necessary squaring operations. Needless to say, if a demand arises for special lengths and dimensions not at present available in this country, and if the Importer of this class of timber is informed, he can notify his shippers in any of the countries which supply heavy constructional timbers, such as British Guiana, Australia, Africa, etc. They can then arrange for these special timbers to be cut and squared to meet this market.

Timber piles are generally required in the sizes 12-in. x 12-in. up to 18-in. x 18-in. and from 10-ft. to 50-ft. and longer in length. If these dimensions are to stand up over the whole length then only the squared pile, i.e. one which is cut from a large tree, can possibly be supplied, since to obtain a round pile having the same diameter at the butt as the tip is virtually an impossibility in view of the taper which occurs in all trees. Certain species do grow with a minimum amount of a taper and the *Eucalyptus* genus from Australia is well known for this characteristic.

Strength and Load Carrying Values.

The question now arises, does the round pile—i.e. the natural tree—possess the same strength value as does the squared pile of a given dimension over its entire length? Before discussing this aspect, consideration must be given to the presence of sapwood which is a natural feature of a growing tree. In the majority of specifications sapwood is treated as a defect, due to its greater liability to attack by wood destroying fungi and by insects. However, it has the advantage of being easily impregnated with a preservative and this point will be discussed under the appropriate section. What is little known is that the strength of wood is practically unaffected by the substances deposited in the heartwood, and as the structure of sapwood and heartwood is fundamentally the same, it stands to reason, and has been shown by thousands of mechanical tests, that, all things being equal, there is little advantage in differentiating between sapwood and heartwood where strength is the main consideration and the wood is *not* likely to be exposed to conditions favourable to decay. Unfortunately this aspect must be considered when dealing with piling timbers, since the situations where their use is required usually favours decay or insect attack.

When considering the relative structural merits of the round pile as opposed to the square it must be remembered that, to obtain a fair comparison, both types of pile must be considered to come from the same log.

If we consider a commercial section such as 9-in. x 9-in., which has an area of 81 square inches, the circumscribing circle would have a diameter of 12.7-in. This would give the round pile an area of 126.65 square inches and consequently this section would carry a direct load approximately 1.57 times greater than the square section. This difference in load carrying capacity will be even more marked when we consider the natural taper of the log, and the largest square section we can obtain from any particular tree, this point being dealt with at a later stage.

As piles in general must be considered as long, slender columns, it is necessary to investigate their load carrying from this point of view.

In determining the axial load that can be carried by a long, slender column, a calculation is made in which the modulus of elasticity is the most important mechanical property involved. Accepting the customary assumptions made in the Eulerian analysis a value may be derived for the magnitude of a load Per known as the Euler load which expressed by

$$\text{Per} = \frac{\pi^2 EI}{l^2}$$

forms the basis of most expressions for the strength of columns. If both sides of the equation are divided by A, the cross-sectional area of the strut or column, the result may be expressed as a stress instead of a load thus:—

$$\text{Per} = \frac{\pi^2 E}{\left(\frac{l}{r}\right)^2} \qquad (1)$$

where π = 3.14159.
E = modulus of elasticity.
l = length of strut.
r = radius of gyration of the cross section.

$$= \sqrt{\frac{I}{A}}$$

where I is the moment of Inertia of the cross section about its weakest axis.

The term $\frac{l}{r}$ is known as the slenderness ratio of the column or strut.

It will be apparent from the above equation that the greater the slenderness ratio the less the column or strut will carry.

In practice the Perry formula is used, which is a modification of Euler and is based on the assumption that the effect of imperfections in workmanship, variation in material and unavoidable eccentricity of loading can be represented as equivalent to an imaginary initial curve of the strut.

The formula is

$$P = \frac{Py + (\eta + 1)\ Pe}{2} - \sqrt{\left(\frac{Py + (\eta + 1)\ Pe}{2}\right)^2 - Py\ Pe} \qquad (2)$$

where P = the intensity of end stress which will cause the maximum fibre stress at some point in the length of the strut to reach the critical value Py.
Py = the critical stress. This is taken as the yield stress for all materials having a real yield point. In timber it may be taken as the ultimate compression stress.
Pe = the Euler stress.
D = an eccentricity coefficient. For free ended timber struts it may be taken as equal to 0.002 $\frac{l}{r}$.

If we plot graphically the values calculated from equation (1), for $\frac{l}{r}$ values from 0 to 200, we obtain a curve, which, for slenderness ratios above about eighty lies very close to the curve plotted for values calculated from equation (2) for the same range of $\frac{l}{r}$

Structural Timber for Dock Work—continued

values. In this range the calculated failing stresses based on the constant E alone gives results very close to those calculated by the Perry formula which takes the ultimate stress into account. As E remains constant in a given species of timber irrespective of the stress grade the obvious inference is that in long slender columns or struts there is no advantage to be gained by using high grade material, a very useful point when considering the economic side of the question. Broadly speaking it may be said that almost any structural grade of timber may be used for long slender columns from the strength point of view.

We have already found that a 9-in. x 9-in. section has a circumscribing circle of 12.7-in. diameter. The maximum square section of any pile will, of course, be determined by the top diameter of the log. A log of 12.7-in. diameter may have, for example, a base diameter of 19.3-in. It would be fair to consider that the strength of the round pile be that determined using the mean diameter. In the case of the log 12.7-in. diameter at the top and 19.3-in. at the base the mean diameter would be

$$\frac{12.7 + 19.3}{2} = 16\text{-in.}$$

The radius of gyration of a circular section with a diameter of 16-in. is 3.98-in., while that of the 9-in. x 9-in. square section is 2.6-in. Put into quantitative terms this means that the load carrying capacity of the round pile is approximately $2\frac{1}{3}$ times that of the square pile as the following figures illustrate:—

$$\frac{\pi^2 E}{\left(\frac{1}{3.98}\right)^2} \times \frac{\left(\frac{1}{2.6}\right)^2}{\pi^2 E} = \frac{1^2}{2.6^2} \times \frac{3.98^2}{1^2} = \left(\frac{3.98}{2.6}\right)^2 = 2.35$$

The engineer will appreciate from this what is being wasted by the use of square piles.

Fig. 1. American method of diagonal bracing to timber bents and method of capping.

A practical advantage of the round pile is that the tendency to turn round is quite immaterial and in cases of difficult driving the time wasted in frequent stoppages for wedging purposes is entirely obviated by their use. Moreover, in conclusion, it may be said that the torsional rigidity of a circular section is better than that of a square section of equal area.

American Classifications.

In studying the tentative specification for round timber piles, issued by the American Society for Testing Materials: D25-52T, one finds that different sizes are used according to the class of work for which the pile is intended. These classifications are as follows:—

Class A: Piles suitable for heavy railway bridges or other heavy framed construction, the minimum diameter of butts permits, in most cases, the use of load bearing timber caps 14-in. in width.

Class B: Are piles suitable in docks, wharves, bridges, building or other foundations with a minimum diameter of butt 12-in.

Class C: Are for foundations which will always be completely submerged, for cofferdams, false work or light construction.

The circumferences and maximum and minimum diameters for these classes vary according to the lengths, but may be briefly shown as follows:—

1. DOUGLAS FIR, HEMLOCK, LARCH, PINE, SPRUCE.

Length ft.	3-ft. from Butt.		At Tip.
	Min. Diam. appr. in.	Max.	Min. Diam. appr. in.
Class A:			
Under 40	13	18	9
40-50 inc.	14	18	9
51-70 inc.	14	18	8
Class B:			
Under 40	12	20	8
40-50 inc.	12	20	7
51-70 inc.	13	20	7
Class C:			
Under 40	12+	20	8
40-50 inc.	12	20	6
51-70 inc.	12	20	6

+ In class C piles, a minimum circumference of 31-in. or diameter of 10-in. at cut-off may be specified for lengths of 20-ft. and under.

2. OAK AND OTHER HARDWOODS, CYPRESS.

Length ft.	3-ft. from Butt.		At Tip.
	Min. Diam. appr. in.	Max.	Min. Diam. appr. in.
Class A:			
Under 40	13	18	9
40-50 inc.	14	18	9
51-70 inc.	14	18	8
Class B:			
Under 40	12	18	8
40-50 inc.	13	20	7
51-70 inc.	13	20	6
Class C:			
Under 40	12+	20	8
40-50 inc.	12	20	7
51-70 inc.	12	20	6

+ See previous note.

Whilst the above are the provisions for the tentative specification the dimensions usually used are from 12-in.—20-in. at the butt, and tip diameters are from 5-in.—9-in. In design work the Americans usually employ an average of 15-in. for the butt and 6-in. for the tip diameters.

Details are given as to general requirements, and it is interesting to note the remarks concerning the presence of heartwood and sapwood. The percentage of the former shall not be less than 8/10ths of the diameter of the pile at the butt, and where the piles are to receive preservative treatment then the piles shall not have less than 1-in. of sapwood at the butt end. Another factor is the condition or extent of peeling, the piles being classified according to the extent of bark removal, i.e. clean, rough or unpeeled. In a note, the hazard of decay or insect damage is considered to be higher in rough-peeled or unpeeled than in the clean. A clean peeling requires the removal of all outer bark and at least 80 per cent. of the inner bark. It is obvious that this material will act as a barrier to the penetration of preservative.

The use of preservatives in this class of timber is directly affected by the species of timber and the presence of sapwood. The heartwood of most timbers is resistant to impregnation, and some indication of these differences is given in Table 3 on the following page.

Since a squared timber involves the loss of sapwood, or if it is specified to be free from such material, then methods of increasing permeability, such as incising, must be resorted to, or alternately the use of a wood which has a high natural durability such as those in columns 1 and 2.

The round pile, on the other hand, has the sapwood complete and since this is always permeable then it is obvious that the heartwood, which is durable, is enclosed by a highly protective barrier against decay and insects. If this should be broken by any means, then entry is permitted for destructive agencies for *Limnoria* will attack any untreated exposed heartwood leaving the treated sapwood severely alone. Any cutting, etc., should therefore be undertaken prior to treatment.

Structural Timber for Dock Work—*continued*

3. CLASSIFICATION OF TIMBERS IN ORDER OF PERMEABILITY

Impermeable 1	Extremely resistant 2	Very resistant 3	Resistant 4	Moderately 5	Permeable 6	Vessel porous 7
Brush Box	Cedar, African pencil	Aspen, Canadian	Balsa[7]	Ash	Alder	Balso[4]
Camphor, East African	Gaboon	Cedar, Western Red	Birch, Canadian Yellow[5]	Birch, Canadian Yellow[4]	Basswood	Bombway, White
Guarea	Greenheart	Chestnut, sweet	Elm, Rock	Celtis[7]	Beech	Celtis[5]
Guarea, Scented	Idigbo	Douglas Fir[5]	Keruing[2,7]	Cottonwood	Birch	Eng.
Jarrah[7]	Iroko	Gum, American Red	Maple, Rock[5]	Douglas Fir[3]	Chestnut, Horse	Gurjun
Karri	Keruing[4,7]	Larch	Muninga	Fir, Silver	Coachwood	Jarrah[1]
Tallowwood	Mahogany, African	Larch, Jap	Obeche[3]	Hemlock, Western	Hornbeam	Keruing[2,4]
Turpentine	Mahogany, Central Amer'n	Oak, American White	Spruce (Home-grown)	Maple, Rock[4]	Lime	Poplar[3]
	Mahogany, Honduras	Oak, Tasmanian	Spruce, Sitka	Opepe	Oak, American Red	
	Nargusta	Obeche[4]	Whitewood European	Padauk, Andaman	Odoko	
	Oak (Home-grown)	Poplar[7]		Pine, Corsican	Podo	
	Padauk Burma	Spruce, Canadian		Pine, Honduras Pitch	Sycamore	
	Pyinkado	Walnut		Pine, Jack	Tupelo gum	
	Teak	Willow		Pine, Pitch		
				Pine, Red		
				Pine Scots (H.G.)		
				Pine, Western White		
				Pine, Yellow		
				Redwood, European		

Where a timber is classified in more than one group the index numbers show the alternative group into which it may fall through variation in permeability.

Whether the round pile is more efficient than the square one for certain purposes, will have to be tested under practical conditions. It is noticeable that when subjected to heavy abrasion* the edges of the square pile are rapidly worn away, and it could be argued that under these conditions a round pile would be preferable. This, in turn, raises another difficulty, particularly in groyne work, namely the fixing of the planking to ensure resistance to the force of the waves, or driven shingle, more particularly when the prevailing drift is affected. In addition it does not permit the staggering of the spikes to increase rigidity. The adzing of a flat bearing surface against which the planks could be fixed should obviate this difficulty.

* See "Dock & Harbour Authority," March, 1953.

Objections have been made concerning fixing of squared timbers to a round pile. The fixing of squared bracing members to round piles constitutes, perhaps, the greatest prejudice that has to be overcome among British engineers. The round pile has been extensively used in marine structures in the United States for the past three centuries (see Fig. 1), the reason being primarily economic. No difficulty has been encountered in fastening square or rectangular timbers to round piles and it is therefore perhaps a little surprising why this construction has not been more readily adopted in the United Kingdom.

The specifications issued to contractors in the U.S. are very complete and concise, and reasonably strict adherence to them coupled

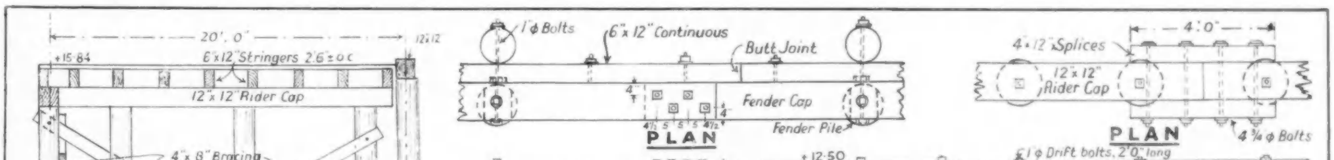


Fig. 2. Miscellaneous details of State Pier, Maine Port Authority, Portland, U.S.A.

Structural Timber for Dock Work—continued

with adequate supervision during constructional operations have resulted in marine structures of top quality.

Methods of Fixing.

While many of the marine structures in the States use only drift bolts and machine bolts as a fastening media, it may be found advantageous in the U.K. to adopt the use of the spiked grid connectors, now readily available, at joints where additional bearing surfaces may be required. Pile caps should bear evenly upon the piles and be fastened to them by one drift bolt at each pile. The bracing of the piles in the bents should be bolted direct to the piles by "bright" bolts, one to be used at each bearing.

Fig. 2 shows some typical details of the Maine Port Authority's State Pier at Portland, Maine. On inspection of the detail showing the fixing of the cap to the fender piles, it will be noticed that the piles have been faced to provide a square bearing for the chocks which must be fitted tightly between the piles and fastened to the

Fig. 3. Potential Piles at Knightwood Enclosure, New Forest, England. Average height 100-ft. at age of 80 years. White band on centre tree is 4-ft. 3-in. above ground.

continuous waling member behind by 1-in. diameter countersunk bolts spaced at 2-ft. 6-in. centres.

This method of "facing" round piles to provide flat bearing surfaces for the bracing members could be readily adopted in the U.K., although in so doing the relative structural efficiency of the round section is reduced.

Does the driving of a square or round pile present any insuperable problem? The square fits into the guides and slides down under the hammer, but should any tendency to twist occur then efforts are necessary to restrict it. The round pile possesses the natural taper, and in driving, this will have to be taken into consideration, but its shape facilitates entry into the ground and any tendency to rotate or twist is of little import. Both types will require correction of lean, if this occurs, but this should be easier with the round pile. Pressure on the point, and stresses set up due to over driving, also friction on the sides of both has to be taken into consideration.

Supply Difficulties.

A timber producing country is always in a better position than an importing country regarding supplies, and where one type of pile has always been used, as in America or Australia, then should another type of timber be required which is not indigenous, the tendency is to demand that the timber be supplied in the form which one has been accustomed to using, and not to alter its shape owing to importation difficulties. Round Greenheart piles are exported to America, but square ones are exported to the U.K. Shipping space and freighterage costs are high and less space is required for the square than for the round. Again one is not shipping extra water in the form of sap in the sapwood when dispatching the squared pile. This in turn reduces weight, an important factor in freighterage charges.

The planting programme of the British Forestry Commission includes a high percentage of soft woods, and whilst it is not intended to enter into a discussion as to the reasons for this, it is obvious that in the years to come we in the United Kingdom, shall be able to supply a fair percentage of our needs from our own resources.

Subject to practical tests, which in themselves will take time, it is conceivable that we should be able to supply piles of certain dimensions from our own forests (see Fig. 3). Our mature hardwoods could supply the shorter length pile, as they do now in squared form, but for long lengths of dimensions as mentioned in the A.S.T.M. specifications, it would require careful silvicultural treatment and time to grow, and it is problematical as to the number of estate owners who would lock up their capital for the requisite number of years of supply piling quality timber.

Thus it appears that in Great Britain our own softwoods offer the best possibility, providing they are pruned and of the requisite quality. We still do not know to what height trees such as Douglas fir, Hemlock, Spruce, etc., will grow in the British Isles since they are of comparatively new introduction, but there is a definite possibility of a source of material becoming available there.

It is obvious that there are points both for and against each type of pile, but both can be supplied in timber and it could be said that the limiting factors are lengths, price and durability. The first two are difficult to overcome since the second factor influences the first, whilst the last can be augmented by existing facilities.

Theoretical studies are never the same as practical experience, and it is felt that if two structures such as a wharf or jetty were to be erected, the one using square piles and the other using round ones, both being subjected to the same loads, then the relative efficiency of both types could be assessed more accurately. Such a test for sea defence groynes is being erected on the South Coast of England†, and the comparative behaviour of each type can be assessed in due course. Again if a specification on similar lines to the A.S.T.M. for round piles were to be compiled for use in this country, then it is conceivable that piles of the round section would be obtainable from home grown resources.

The writer has attempted to put as unprejudiced an aspect upon round versus square piles, and there must be many aspects which have been omitted. It is hoped, however, that it will have shown another aspect of the controversy which exists on this subject. His thanks are due to those who have assisted him in giving information which he is unqualified to supply, and in particular to Mr. J. D. M. Luttman-Johnson of Messrs. Fay, Spofford & Thorndike of Boston, Mass., who have supplied such valuable information of American practice and drawings.

Liverpool Port Charges Increased.

In order to raise additional revenue to meet increased operational expenditure in connection with major capital works at present being undertaken at the Port of Liverpool, the Mersey Docks and Harbour Board has found it necessary to increase its rates and dues for the use of the port by percentages ranging from 12½ to 66 2/3.

Tonnage rates, wharf rates and town dues were increased by 12½%. Harbour rates levied on ships entering the Mersey, but not necessarily using the docks, rose by 66 2/3%.

The increases which took effect on September 7th were agreed by the Board last month after it had been reported that the Minister of Transport had no objection.

† See "Dock & Harbour Authority," May, 1953.

The Corrosion of Iron and Steel and its Prevention

With Special Reference to Harbour and Dock Installations

By J. C. HUDSON, D.Sc., D.I.C., A.R.C.S., F.I.M.
(British Iron and Steel Research Association)

(continued from page 116)

5. Practical Experience.

The preceding sections of this article have in the main been theoretical or based on the results of small-scale experimental work. It may be of interest to supplement them with descriptions of a few practical examples of corrosion and its prevention occurring under conditions similar to those encountered in harbours and docks.

5.1. Corrosion of Roofing Sheets.

Trouble is sometimes experienced from the corrosion of steel roofing sheets. The secret here is to pay careful attention to maintenance, which is cheapest when carried out at the correct intervals. On the whole, it is difficult to make good a badly rusted sheet and, if a roof has been neglected, it may be more economical to let it corrode to destruction and then start again with new sheets.

It is a mistake to economise unduly on the gauge of sheet or the weight of coating. It is essential that the basis steel should be sufficiently thick to provide a reasonable resistance to corrosion if, as is not uncommon, painting is not carried out at the right time and some failure of the zinc coating is allowed to occur. In this respect, the use of copper steel for the sheets provides an additional margin of safety. (See section 4.4).

The effect of the thickness of the zinc coating is shown by the calculation, based on experimental data, that a coating of $1\frac{1}{4}$ oz. per sq. ft. (sum for both sides), such as is common on galvanised sheets, would withstand corrosion for about $7\frac{1}{2}$ years in a mildly corrosive marine atmosphere not contaminated with sea-salt spray or industrial pollution. An increase in coating weight of only $\frac{1}{4}$ oz. per sq. ft. to $1\frac{1}{2}$ oz. per sq. ft. would prolong this life to nine years. These, of course, are the maximum periods that could be allowed to elapse before painting the sheets. The calculations assume that the coating thickness is uniform all over the sheet. In practice this is not the case and the first development of rust on the sheet will be determined by the coating thickness at the thinnest point. Here the newer continuously galvanised sheets are at an advantage as compared with the general run of singly galvanised sheets, for, as shown in Fig. 21, the distribution of the coating on them is much more uniform.

The painting of new galvanised sheets may give rise to difficulty, because, as a rule, paints do not adhere well to a bright zinc surface. The difficulty can be overcome by weathering the sheets until they have lost their spangle, or, if this is impracticable, by treating the surface of the sheets chemically. Phosphoric acid washes are probably the best solutions to use. Amongst these the most recent development are the so-called "wash-primers," which originated in the United States during the Second World War. They are derived from the simpler phosphoric acid washers by substituting an alcoholic solution of the synthetic resin, polyvinylbutyral, for the aqueous medium originally used and by adding some chromate pigment. The "can stability" of wash primers is poor; so they are generally supplied as two components, as in the following American specification (U.S. Bureau of Ships Formula No. 117).

Pigment-base.	% by weight.
Polyvinylbutyral resin	9.0
Basic zinc chromate	8.6
Magnesium silicate	1.3
Lamp black	0.1
Butyl alcohol, normal	20.0
Ethyl alcohol	61.0
	100.0
Acid diluent.	
85% phosphoric acid	18.0
Ethyl alcohol	65.9
Water (maximum)	16.1
	100.0

The wash primer is prepared immediately before it is needed for use by stirring in one volume of the diluent into four volumes of the pigment-base, after thoroughly mixing up the latter. It is applied by brushing or spraying at a rate of about 350 sq. ft. per gallon. This yields a dry film thickness of about 0.4 mil., which does not suffice to hide the base metal completely. A wash primer is, therefore, not to be regarded as a substitute for a coat of paint and the full painting scheme called for by the conditions of service should be applied over it. With a few exceptions, all types of paint adhere to surfaces prepared in this way, and although the method has been specifically mentioned in connection with the painting of galvanised sheets, it is also of practical value for bare steel, which should preferably be descaled, unrusted and degreased, and for certain non-ferrous metals.

The choice of a priming paint for a galvanised surface does not seem to be critical when the surface is properly prepared for painting as indicated above. Otherwise, there may be an advantage in using a paint pigmented with zinc dust and zinc oxide, because this type of paint adheres well even to new galvanised sheets. Its good performance on such surfaces has been demonstrated in the United States and confirmed by tests in Great Britain, as is shown by the photographs reproduced in Fig. 22, for which the author is indebted to Messrs. R. E. Shaw and A. A. Blake. There is an American Federal Specification TT-P-641:1939 for zinc dust/zinc oxide paints. The ratio of the pigments is usually about four parts by weight of zinc dust to one part of zinc oxide, and the specification covers paints in three media: linseed oil media for general purposes, alkyd media for stoving paints and phenolic resin media for water-resistant paints.

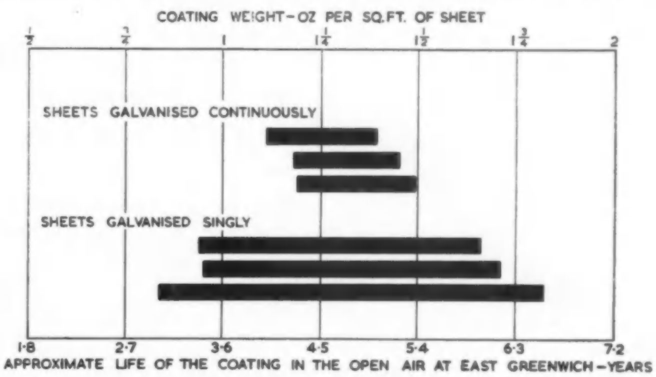


Fig. 21. Variation in Coating Weight on Galvanised Sheets. This diagram is based on observations by Dr. M. L. Hughes and shows the range of the coating thickness at any point on three sheets galvanised by the continuous process and on three sheets galvanised singly. Both sets have roughly the same average coating weight, about $1\frac{1}{4}$ oz. per sq. ft., but for the former the overall variation is from 1.1 to 1.5 oz. per sq. ft., as compared with from 0.8 to 1.8 oz. per sq. ft. for the latter. If the sheets were exposed outdoors in a moderately corrosive atmosphere, e.g. at East Greenwich (see Fig. 5), failure of the coating at their thinnest points would be expected after about 4.0 and 3.0 years, respectively.

5.2. Protection by a Metal Coating.

There is a notable example of the protective value of a sprayed metal coating on steel at the works of Messrs. Brown Bayley Steels Ltd., situated in the industrial area of Sheffield. In 1937 this company built a new test house and made its walls of $\frac{1}{8}$-in. steel plate (Fig. 23). The steel was protected by spraying it with aluminium, a process that was more or less novel at the time. A 3-ft. dado all round the building was coated with two coats of black

Corrosion of Iron and Steel—continued

bituminous paint; otherwise the only organic finish given to the aluminium coating was a single coat of lacquer.

The building was made into a strong point in 1939 and received no maintenance painting during the Second World War. In 1946 two coats of aluminium paint were applied to the outer surface of the plates. When inspected in 1952 the coating was found to be giving efficient protection to the steel, although it was reaching the stage at which the further application of paint was desirable. There were a few patches of rust on the plates, but these were mainly at places where the walls had been encased in a sand revetment during the war period. For all practical purposes the steel had been protected perfectly in a severely corrosive atmosphere for 14 years.

5.3. Steel Piling.

In reply to a technical enquiry about the probable life of steel piling to be used to retain the back of a water reservoir situated in gault clay, it was calculated from experimental data that steel piling with a $\frac{1}{4}$-in. web should have a life of at least 20 years even in the most corrosive soils. This estimate seems to have been unduly conservative, for the experience of several steel companies who roll piling sections, and were good enough to advise the author, is that steel piling can be used for all normal purposes whether in the soil or in salt or fresh water, without fear of failure through corrosion. Evidence of this is given by the results of tests and observations made by M. Blach and A. Rogberg[14] at the Port of Copenhagen.

They concluded that the effective life of a Larssen No. 3 section, with a web thickness of 0.55-in., would be about 55 years, i.e. that this period would elapse before the necessary mechanical properties of the pile were dangerously weakened by corrosion.

Old Brunswick Wharf, Blackwall. Under favourable conditions even longer lives are to be expected. In 1951, through the courtesy of the Port of London Authority, the author inspected pieces of old cast iron from the Old Brunswick Wharf at Blackwall, which had been demolished a few years previously. The construction of this wharf, which was among the earliest of its kind, took place in 1833 and is described by M. A. Borthwick in the very first volume of the Transactions of the Institution of Civil Engineers[15]. After nearly 120 years' service there was no serious corrosion of the cast iron, possibly because the piles had been driven into gravel. There was no evidence of graphitisation on the sections examined.

5.4. Piers and Harbour Installations.

The protection of piers and harbour installations is a difficult matter, particularly for those parts of the structure that are permanently immersed in sea-water and thus inaccessible for maintenance. It is essential wherever possible to keep the protective coating in good repair. For example, some years ago it was necessary to replace several of the pontoons supporting the floating landing stage at Gosport, because they had been perforated by rusting. After an inspection made through the courtesy of the Borough Engineer, Mr. A. Barlow, A.M.Inst.C.E., it was concluded that the severe pitting had originated several years previously, when an interval of seven years had elapsed before the renewal of the protective coating. It seems wise to recondition or renew the protective coating on structures of this type at intervals of not more than three or four years; in fact, some authorities recommend shorter periods than this.

Two general points are important in this connection:—

(1) The structure should be designed in such a way as to facilitate the application of protective coatings. This is certainly not the case for the intricate cross-bracing beneath many of our older marine structures, such as seaside piers, parts of which are practically inaccessible.

(2) Protection against the removal of the protective coating by mechanical abrasion from sand or shingle should be provided. For example, G. W. Oxley[16] describes how the underwater steel surfaces of drilling and power barges in the Gulf of Mexico have been covered with a protective scheme consisting of a marine priming paint, followed by a heavy coat of high melting point asphalt about $\frac{1}{4}$-in. to $\frac{1}{2}$-in. thick, tar paper and creosoted wood. The timber serves as a barrier to protect the asphalt from gouging by small boats, drift wood, etc. According to reports, from five to ten years' service can be expected from such protection.

5.5. Cast Iron or Steel Mains Laid on the Sea Bed.

On several occasions the author's advice has been sought regarding the protection of gas or water mains laid on the sea bed. In one case a 10-in. water main laid across a tidal estuary began to leak badly within nine years. The main consisted of steel tubes coated externally with bitumen; after laying it was surrounded in some parts with a concrete mixture to give additional protection. The leaks seem to have started at places where the protective coating had been penetrated by crustaceans.

The opinion was expressed that something might be done under such circumstances to obtain a reasonable service life by increasing the wall thickness of the pipe. On the basis of small-scale experimental results, it was calculated that, whereas a pipe with a wall thickness of 0.14-in. might be expected to last for about 20 years, one with a wall thickness of 0.35-in. should last for about 50 years. The life could be further prolonged by the use of zinc or bituminous coatings, preferably together. It was improbable that any modifications in the composition of the iron or steel would have any appreciable effect in increasing the life of the pipe.

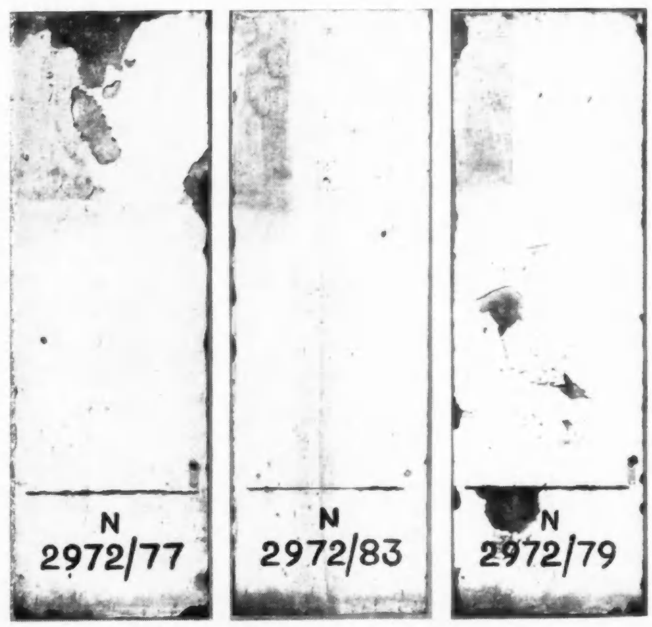


Fig. 22. Performance of Paint on Untreated Galvanised Sheet (R. E. Shaw and A. A. Blake).
Left: Red lead priming paint. Centre: Zinc dust/zinc oxide priming paint. Right: Red oxide priming paint. Each panel was given a single priming coat, followed by two finishing coats of the same glossy cream enamel. They were then exposed outdoors for three years at the test site of Messrs. I.C.I. Ltd. (Paints Division), Slough.

5.6. Protection by Concrete.

It is generally agreed that a good thick coating of dense concrete gives lasting protection to steel. It is, therefore, of the utmost importance to design a reinforced concrete structure in such a way that the steel is adequately covered at all points. The use of

[14] M. Blach and A. Rogberg: "Sheet Pile Corrosion at the Port of Copenhagen." The Engineer, 1947, 183, Apr. 25, 348-350.

[15] M. A. Borthwick: "Memoir on the Use of Cast Iron in Piling, particularly at Brunswick Wharf, Blackwall." Transactions of the Institution of Civil Engineers, 1836, 1, 195-205. (This is an extremely interesting article on the early applications of iron piling; sections or castings with dovetailed edges were first introduced round about 1820-1830. Borthwick speculates on "how iron is affected by water," and would have been gratified to know that his paper has proved helpful in obtaining evidence of this.)

[16] G. W. Oxley: "Coatings for Protection of Steel in Water." Paint and Varnish Production, 1951, March, 10-13.

Corrosion of Iron and Steel—*continued*

correct concrete mixtures and proper consolidation of the concrete are other vital factors. Where failure through rusting has been observed in a concrete structure, it has usually been traced to faulty practice in one or more of these respects.

Messrs. Holland and Hannen and Cubitts, Ltd., who have kindly communicated the results of their experience in this field to the Corrosion Committee, state that they specify a 2-in. cover of concrete of 3 : 1½ : 1 mix for all precast reinforced piles and have no record of any failure. They were probably the first firm in Great Britain to drive piles of this type; when the old piles driven in 1890 or so were inspected in 1937, these were found to be in perfect condition. Moreover, some crane pontoons constructed by them during the 1914-1918 war, by fixing expanded metal on reinforced concrete ribs and plastering on sand and cement mortar to a total thickness of 3-in., the cement rendering being trowelled to a very hard face, were still in service in 1940.

The necessary density of concrete to give the required protective covering is ensured by the use of a carefully proportioned mix thoroughly consolidated, the consolidation being preferably secured by the use of vibrators. Under corrosive conditions increased protection is frequently obtained by the use of sulphate-resisting cements, while the possibility of moisture reaching the reinforcing steel through small cracks can be entirely eliminated by the technique of prestressing.

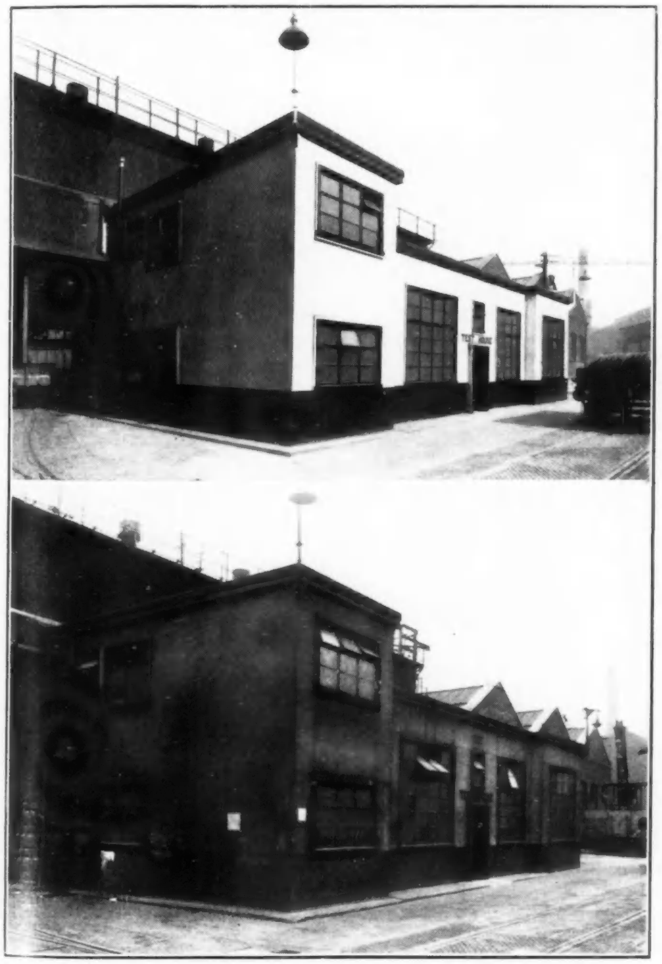


Fig. 23. **Protection of Steel by a Sprayed Metal Coating.** The upper photograph shows the Test House of Messrs. Brown Bayley Steels Ltd. at Sheffield shortly after its outer steel walls had been sprayed with aluminium and lacquered in 1938. The lower photograph was taken in 1952, after the patches had been cleaned to reveal the condition of the aluminium coating.

5.7. Cathodic Protection.

So far no reference has been made in this section to cathodic protection. This is because most of the corrosion problems discussed arose several years ago and it has been thought better to give the solutions suggested at the time. In the light of more recent knowledge, it is clear that some of the problems would have been appropriately dealt with by using cathodic protection. For instance, this seems to be the ideal solution of the problem of protecting a steel pipe laid on the sea-bed or buried in the soil, and the method has been used in recent years for the oil pipe line running from the Firth of Clyde to the Firth of Forth. The pipeline has been coated with an asphalt/asbestos mastic, about ¼-in thick, in the normal way and is connected to 22 lb. magnesium anodes buried alongside it at intervals of about 250 yards. These anodes are expected to last for 15 to 20 years before replacement is necessary; if so, the annual cost of cathodic protection, which should prevent rusting entirely, will be approximately £3 per mile.

Clearly, there is great scope for the application of cathodic protection to many types of harbour installations that are immersed in the sea, such as wharves, jetties and lock gates, or buried in the soil, such as steel piling. So far little use has been made of the method in this country but there is no doubt that, as experience of its value grows, it will be employed to an increasing extent.

6. Conclusions and Recommendations.

6.1. General.

In concluding this article a few comments may first be made on two points raised by Mr. Ordman, namely, the protective treatment of rusted steel surfaces, and the testing of proprietary materials.

(i) **Paints for unprepared steel surfaces.** Mr. Ordman referred to the great need for a reliable protective treatment that could be applied to steel that had not received an elaborate and costly surface preparation, i.e., to steel carrying rust. This represents a philosophers' stone of research on protective painting, for it is certain that the development of paints that would perform satisfactorily when applied directly to steel in a badly rusted condition would be of great practical value. As Mr. Ordman says, it is difficult to assess the claims in this direction made for various proprietary materials but, in the author's view, a complete solution of the problem has yet to be found. Some progress toward it has undoubtedly been made by the introduction of the so-called "zinc-rich" paints, largely as a result of research by Dr. U. R. Evans and Dr. J. E. O. Mayne at Cambridge University. These are paints that are so tightly packed with zinc dust that the metallic particles are in electrical contact with each other in the dry paint film. As, moreover, the zinc dust makes electrical contact with the steel base, cathodic protection is achieved at any point when the paint film is imperfect or becomes damaged. Paints of this type give excellent performance on rusted steel immersed in sea water, lives of up to two years having been observed in laboratory tests from single coats.

It is essential, however, that the zinc content of the dry paint film should be at least 92-95 per cent. by weight, according to the medium used, because, below this figure electrical contact between the zinc particles is not obtained.

(ii) **Testing of Proprietary Materials.** Mr. Ordman also suggested that it was desirable to provide some mechanism whereby independent tests could be made of proprietary protective processes, with a view to issuing an impartial assessment of their merits. A discussion of this point really takes us outside the realm of science into a domain where everyone has his own personal opinion, which inevitably is affected to some extent by his personal interests.

Clearly it is desirable from the users' point of view that some such facilities should be provided, possibly by establishing a central testing institute. The Corrosion Committee of the British Iron and Steel Research Association have, however, always held the view that it would be unwise for them to undertake *ad hoc* tests on proprietary materials, because they feel that the results might lend themselves to abuse and misrepresentation. On the other hand, the American Society for Testing Materials take a somewhat different attitude and have recently decided to make their exposure stations available for such tests, provided that certain condiions and safeguards are complied with.

Corrosion of Iron and Steel—continued

It is possible that in the course of time the need for tests on proprietary materials will decrease, because there will be less reluctance on the part of manufacturers to give the formulation of their products—in the United States it is not uncommon for the formulation of a paint to be given on the tin. In cases where the legitimate interests of the manufacturer would be prejudiced if he were to divulge the composition of his coating, its value can often be checked by submitting it to a performance test in the laboratory. Appropriate tests for various purposes are being devised and standardised to an increasing degree; their application to check that a particular material complies with a given standard would seem to fall most appropriately within the province of a qualified private consultant.

6.2. Recommendations.

Seven practical recommendations regarding the prevention of rusting can be deduced from this survey of the corrosion of iron and steel, namely:—

(i) Take care when designing structures to avoid details that will favour corrosion or will impede the application of adequate protective measures. "The prevention of corrosion begins on the drawing board."

(ii) Use rust-resisting materials where the expense is justified: stainless steels for special purposes and low-alloy steels for general structural work. In some cases where ordinary steel is used a slight increase in the stoutness of the sections may considerably prolong the life of the structure or parts.

(iii) Do not economise unwisely on protective measures. Plan these beforehand and remember that the costs of maintenance will often dwarf those of the initial protective scheme.

(iv) Make use of air-conditioning, water-treatment, cathodic protection and similar measures, where appropriate and economical.

(v) Pay a reasonable price for protective materials. Good quality and adequate coating thickness are essentials for efficient protection.

(vi) When painting steel, give careful attention to surface preparation. For general structural purposes, use a mixed red lead and white lead in linseed oil priming paint and allow it to dry thoroughly. Then follow with two or more coats of good finishing paint. For steel immersed in water, good results will be obtained from paints pigmented with basic lead sulphate, aluminium and extender and bound in media of the modified phenolformaldehyde/stand oil type.

Apply all paints under good weather conditions and aim at building up an adequate paint film thickness: 5 mils minimum for land structures, 7 mils minimum for ship's bottoms and totally immersed steelwork.

(vii) For steel exposed to severely corrosive conditions, apply a metal coating beneath the paint. Zinc and aluminium are the most practicable coatings for the general run of structural steelwork. There is little to choose between them for protection against atmospheric corrosion but for steel immersed in sea- or fresh-water zinc is to be preferred.

6.3. Bibliography.

References to the scientific literature bearing on some points of detail have already been given in the text. The following is a short selected bibliography for those who may wish to study the subject further.

GENERAL CORROSION THEORY.

[1] **U. R. Evans.** "An Introduction to Metallic Corrosion". Edward Arnold & Co., London, 1948.

SULPHATE-REDUCING BACTERIA.

[2] **K. Butlin and W. H. J. Vernon.** "Underground Corrosion of Metals: Causes and Prevention." Journal of the Institution of Water Engineers, 1949, 3 (Nov.), 627-637.

ATMOSPHERIC CORROSION.

[3] **H. Baudot and G. Chaudron.** "Essais de corrosion naturelle de longue durée sur divers aciers de construction." Revue de Métallurgie, 1946, Jan.-Feb., 3-67.

[4] **J. Newton Friend.** "Deterioration of Structures of Timber, Metal and Concrete exposed to the Action of Sea-water." Eighteenth Report of the Committee of the Institution of Civil Engineers. The Institution, London, 1940.

[5] **J. C. Hudson.** "Present Position of the Corrosion Committee's Field Tests on Atmospheric Corrosion—Unpainted Specimens." Journal of the Iron and Steel Institute, 1943, No. II, 161P-215P.

CORROSION BY SEA-WATER.

[6] **J. C. Hudson.** "Corrosion of Bare Iron or Steel in Sea-Water." Journal of the Iron and Steel Institute, 1950, Oct., 123-136.

[7] **British Iron and Steel Research Association—Industrial Waters (Corrosion) Sub-Committee.** "Corrosion of Iron and Steel by Industrial Waters and its Prevention." The Iron and Steel Institute, Special Report No. 41. The Institute, London, 1949.

SOIL CORROSION.

[2] Reference as above.

[8] **Ministry of Health.** Interim Report of the Departmental Committee on the Deterioration of Cast Iron and Spun Iron Pipes. H.M. Stationery Office, London, 1950.

[9] **I. A. Denison and M. Romanoff.** "Soil Corrosion Studies 1946. Ferrous Metals and Alloys." Journal of Research of the National Bureau of Standards, 1950, 44, 47-76. "Corrosion of Low-Alloy Irons and Steels in Soils." Ibid, 1952, 49, 315-323.

[10] **The Iron and Steel Institute.** "Corrosion of Buried Metals." The Iron and Steel Institute, Special Report No. 45, The Institute, London, 1952.

CATHODIC PROTECTION.

[10] Reference as above.

PROTECTIVE COATINGS.

[11] **F. Fancutt and J. C. Hudson.** "The Work of the Protective Coatings (Corrosion) Sub-Committee." Journal of the Oil and Colour Chemists' Association, 1952, 35, Aug., 396-415. Also published in "Corrosion," 1952, 8, Nov., 366-374.

[12] **F. Fancutt and J. C. Hudson.** "Protective Painting of Structural Steel," Journal of the Iron and Steel Institute, 1942, 145, No. I, 87P-100P.

[13] **J. C. Hudson and W. A. Johnson.** "Protection of Structural Steel against Atmospheric Corrosion." Journal of the Iron and Steel Institute, 1951, 168, June, 165-180.

[14] **Steel Structures Painting Council.** "Surface Preparation Specifications."

No. 1. Solvent cleaning.
No. 2. Hand cleaning.
No. 3. Power tool cleaning.
No. 4. Flame cleaning of new steel.
No. 5. Blast cleaning to "white" metal.
No. 6. Commercial blast cleaning.
No. 7. Brush-off blast cleaning.
No. 8. Pickling.
No. 9. Weathering and cleaning.

Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh 13, Pa., Aug. 1952.

[16] **J. C. Hudson and T. A. Banfield.** "The Protection of Steel by Various Non-Metallic Coatings." Journal of the Iron and Steel Institute, 1948, Jan., 99-110.

ANTI-FOULING COMPOSITIONS.

[17] **Woods Hole Oceanographic Institution.** "Marine Fouling and Its Prevention." United States Naval Institute, Annapolis, Maryland, 1952.

ERRATUM.

On page 47, under Contents, read:
"5.3. Steel Piling: Old Brunswick Wharf, **Blackwall.**"

The Paint Advisory Committee

Fuller Representation for the Industry

The Board of Trade have decided to effect several changes in the character and composition of the Paint Advisory Committee. When the committee was instituted some 10 years ago its function was to advise the Government on the problems arising from the wartime control of the paint industry and to this end its members were selected, not as representatives of the various sections of the industry, but as men of standing and experience who would be most capable of offering independent advice. Following recent consultations between the Board of Trade and the committee it was agreed that the need still existed for an advisory body but that certain changes were necessary in its consitution. In future the committee will have members representing the three trade associations and the export group as well as its independent members and trade union representation will be widened.

A Mud Meter

Measuring Quantities of Dredged Materials

By Masao KONDO, Gentaro HASEGAWA, and Yutaka IMURA
of the Japanese Transportation Technical Research Institute.*

1. Introduction.

Methods of measuring the dredged quantity are classified into three groups, namely:

(1) Measurement of water depth (sounding) and determination of the points of measurement on the map. The measurement, made before and after the dredging, makes it possible to determine the dredged quantity.

(2) Evaluation of the space that is filled up with the mass dredged.

(3) Measurement during dredging; for instance, reckoning the number of filled buckets or hoppers of known capacity.

Both (1) and (2) give the integrated quantities dredged during a certain length of time, while (3) may be said to give instant values of the quantity being dredged. In the case of dipper dredges, bucket dredges or grapple dredges, the measurement (3) can be easily made, but no definite means have yet been found to reveal the instant activity of hydraulic pipe-line dredges. This paper deals with a Mud-Meter recently developed by us for measuring the instant quantities of dredged materials which run through the discharge pipe-line.

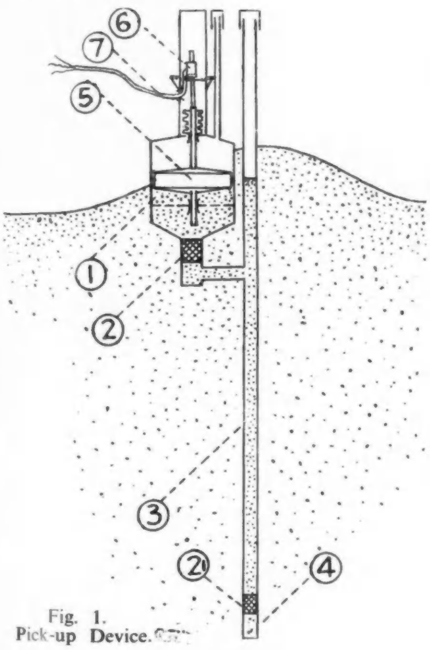


Fig. 1. Pick-up Device.

2. Principle of the Mud-Meter.

Take a known volume of muddy water and weigh it.(1) Then the quantity of mud can be evaluated so long as the density of mud is known. This is quite a simple physics, but when we notice that theoretically the weighing is not effected by any horizontal movements of the water and mud, we can

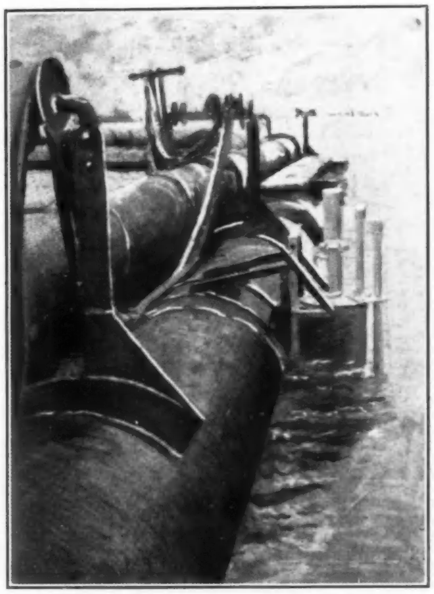


Fig. 2. Pick-up Device fixed to a Pontoon.

easily understand that this principle may be applied to measuring the mud contents of water running horizontally through a discharge pipe-line of a hydraulic dredge.

Suppose we cut off a horizontal pipe of a certain length at both its end-joints, and make the pipe vertically free, and weigh the pipe through which muddy water is running. Then the quantity of mud contained in the water which filled the pipe at the moment of weighing can be evaluated, irrespective of the running speeds of the water and the mud. And if the instant velocity of mud is known, the whole quantity of mud which runs through the pipe will be obtained by integration.(2)

3. Method of Weighing a Discharge Pipe.

The discharge pipe-line of a hydraulic dredge consists of a number of pipes which are mounted on pontoons. The measurement of the draught of these pontoons is a convenient method of arriving at the weight of a unit pipe. In the case of an ordinary pontoon, simple calculations show that the change of the water-line amounts to 15-30 mm. for a 10 per cent. volume change of mud when the true density of mud is taken to be 2.5 gr./cm^3. The lengths or displacements of such an amount may be easily measured if the water is calm, but when the water surface is agitated by swell or waves the mean water-line has to be measured. For this purpose a pick-up device shown in Fig. 1 has been worked out which is fixed firmly to a pontoon as shown in Fig. 2.

The water in the float chamber (1) goes through the resistance filters (2) and (2'), and connects with the water outside at the bottom opening (4) of the vertical pipe (3) about 2 or 3 metres long. By this arrangement, the float chamber water level, being kept free from faster changes of the outside water level as well as from any vertical accelerations of the pontoon, indicates the mean water-line, which is transferred to the position of the float (5) of 30 cm. diameter designed to move the attached dial indicator (6). The dial indicator (6) has a simple set of duplicate rotating switches on its shaft,

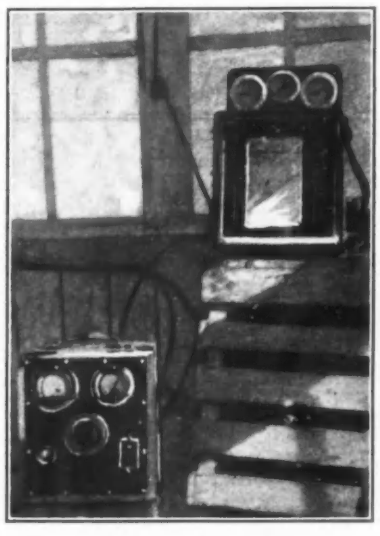


Fig. 3. Receiving Set and Eliminator Box in the Drivers' Room.

and transmits electrical on-off signals by the 3-ply cord (7) to its receiving set. Fig. 3 shows the receiving set in the drivers' room.

4. Method of Remote Indication.

For the remote indication and record of the position of the float (5) in Fig. 1, "K-T.-Wheel System"(3) is used. This is a two-way step indicator having two circuits connecting a transmitter and a receiver.

5. Evaluation of Mud Speed.

The receiving set, as shown in Fig. 3, has two units of an indicator and a recording pen

*Paper published by Unyu-Gigutsu Kenkyujo, Tokyo, Japan.

(1) The weight is expressed as follows:

$$W_p = \rho_1 V \frac{100+(\rho_2/\rho_1-1)p}{100}$$

where ρ_1......... density of water
ρ_2......... true density of mud
p......... volume percentage of mud
V......... total volume

(2) This principle resembles the one that makes a weighing device of a constantly moving belt conveyor indicate the instant quantity of the material carried on the belt and the whole amount integrated by the speed of the belt.

(3) Japanese Patent No. 191856.
Kikai no Kenkyu, No. 7, Vol. 4 (1952) pp. 409-412.
Full details will be given in a *Report of the Transportation Technical Research Institute*.

A Mud Meter—*continued*

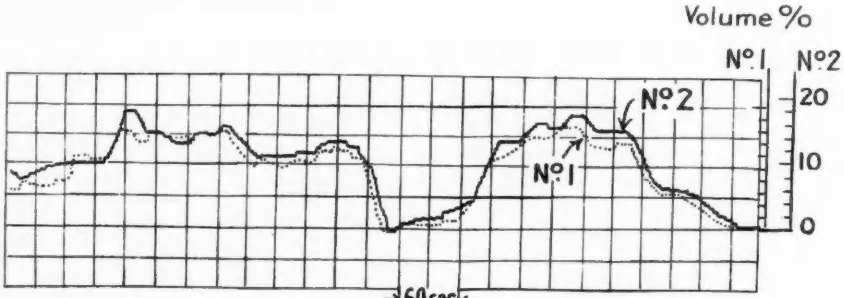


Fig. 4.
Normal Recording.

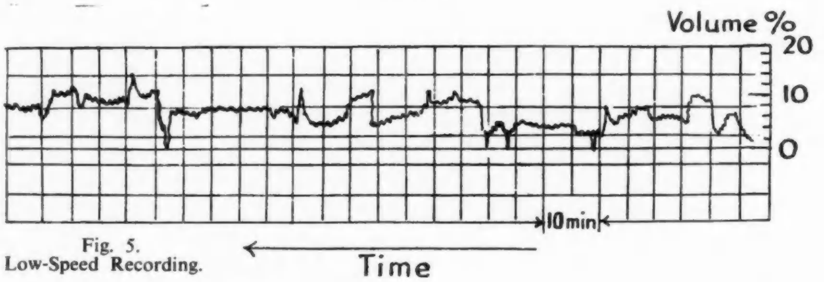


Fig. 5.
Low-Speed Recording.

in order to receive signals of two pick-ups. When we set these two pick-ups at a certain interval along the discharge pipe-line, their indicating pens in the receiving set record similar shapes which are as much apart from each other as the time required for the mud to move from No. 1 pick-up to No. 2 pick-up.

By measuring the time shift of the two curves, the mean velocity of mud is obtained.

Fig. 4 presents a part of the records, in which the curves No. 1 (red line) and No. 2 (a blue line) correspond to the pick-ups No. 1 and No. 2 respectively. In the design of the receiving set, No. 2 recording pen is located 10 mm. ahead of No. 1, that is, the curve No. 2 is recorded 30 sec. in advance of the curve No. 1. Therefore, the curve No. 2 of Fig. 4 is, in fact, recorded 24 sec. later than the curve No. 1 on an average while No. 2 pick-up is fixed to the pontoon which is 102 meters downstream from that of No. 1 pick-up. The mean velocity of mud is therefore calculated as 4.2 m/sec. $\left(=\frac{102}{24}\right)$.

As shown in Fig. 4, the two curves are almost similar to each other except that the curve No. 2 is somewhat flatter than the curve No. 1. The difference of the percentage scales is due to the difference of the pontoons in size.

An example of low-speed recording is shown in Fig. 5.

6. Influence of Neighbouring Pontoons on the Draught of the Pick-up Pontoon.

If the mud content is the same along the pipe line, draughts are also the same for all pontoons. Therefore, it is only the draught change that is necessary for the evaluation of mud content. But when the mud content is not uniform along the pipe-line, the draught of a pontoon will be affected more or less by neighbouring pontoons. In this case the draught change of pontoons w is expressed as follows.

$$w(x)=\frac{1}{\sqrt{8}k^{\frac{3}{4}}R^{\frac{1}{4}}}\int P(\xi)e^{\mp\frac{\beta}{\sqrt{2}}(x-\xi)}\left[\cos\frac{\beta}{\sqrt{2}}(x-\xi)\mp\sin\frac{\beta}{\sqrt{2}}(x-\xi)\right]d\xi$$

where upper sign when $x > \xi$, lower sign when $x < \xi$,

$P(\xi)$; Load of unit length at ξ.

k; Spring constant of buoyancy for unit length.

R: Average flexual rigidity of the pipe-line. This is approximately expressed in $EI\frac{L}{l}$, where EI is the flexual rigidity of joint members, the length of which is l, and L is the length of a unit pipe.

$$\beta=\sqrt[4]{\frac{k}{R}}$$

But in ordinary operating conditions we can take $w(x)$ approximately equal to $\frac{P(x)}{k}$.

7. Note.

In December, 1951, the first test of the original mud-meter which had been made in our laboratory was carried out successfully. At that time the mud-meter had only one pick-up and one indicator.

Then by the ingenious suggestion of Mr. R. Hatta who was the chief designer of the Watanabe Seiko Co. (a dredge manufacturing company), the two-pick-up system was introduced for measuring the mud speed in a discharge pipe-line as well as the mud content.

In 1952, five hydraulic pipe-line dredges were equipped with the mud-meters here reported, and various experiments are now being carried on chiefly for the analysis and improvement of the working ability of hydraulic dredges.

Meanwhile the present writers devised a new weighing apparatus, which is mounted on a dredge without being helped by a pontoon. The design and construction of this apparatus have been undertaken by the Watanabe Seiko Co. for which the Japanese Government granted a subsidy for the year 1952.

(Patents in Japan for the mud-meter are pending.)

Cargo Traffic at New York

Decline in Tonnage Handled

According to an analysis of foreign trade figures recently issued by the Port of New York Authority, the volume of cargo tonnage dealt with at New York last year totalled 12,683,052 tons, a decline of 5.1 per cent. compared with the total for 1951. Total import-export tonnage during the year for all U.S.A. ports declined from 40,903,449 tons in 1951 to 38,555,163 tons, a decrease of 5.7 per cent.

The decline in the tonnage passing through New York last year reflects the decline in the nation's shipping business, which is expected to be worse this year. Exports through the port fell from 6,233,402 tons in 1951 to 5,770,826 tons, a decrease of 7.3 per cent. for the port as compared with a national export decline of 7.5 per cent.

Imports dropped from the 1951 total of 7,141,686 tons to 6,912,226 tons, a reduction of 3.2 per cent. for the port compared with a national import decline of 4 per cent.

New York's share of the country's total export and import trade increased from 32.7 per cent. in 1951 to 32.9 per cent. in 1952. This was mainly due to increased oil products, which are handled largely through mechanically operated terminal facilities requiring very little manual labour.

The total tonnage of foreign trade through the port increased from 32,479,595 tons in 1951 to 32,871,595 tons last year. While the port's bulk tonnage increased from the 1951 total of 19,114,222 tons to 20,188,543 tons in 1952, the nation's total volume, due mainly to a decrease of about eight million tons in coal exports, declined from the 1951 figure of 137,344,838 tons to 135,410,341 tons.

The analysis shows that the port handled more than one half of the total national volume of many of the most important individual general cargo items. Among the main exports were motors, motor spares, agricultural machinery, tyres and glass, and among imports were beverages, coffee, hides, skins, canned fish and spices.

Oscillations of the Sea and the Phenomenon of Range

Part 4. Origins of Range Action: Wind and Air Waves

By B. W. WILSON, D.Sc., C.E. (Illinois), A.M.I.C.E., Assoc.M.ASCE., A.M.(S.A.)I.C.E.

(continued from page 109)

Generation of Sea-Waves by Wind (And Air-Waves).

A considerable body of evidence can be brought to bear on the contention that air waves are as much a common feature of the atmosphere as sea waves of the oceans. To avoid burdening the present theme, we shall abstain from any presentation here of supporting facts and merely adopt the premise that air-waves are a reality capable of physical expression in both barometric and anemometric fluctuations.

It seems entirely rational to suppose that if a wind stream, exerting traction on the surface of the sea can generate water-waves in that fluid medium, then corresponding waves must, *ipso facto*, be set up in the atmospheric medium immediately overhead.

It may thus be supposed that there is a natural tendency for the building-up of a joint state of oscillation between air and water when air-currents exert traction on the surface, and that the periodicities of such oscillations will be dependent on the average wind-speed.

Now it has already been pointed out that within the range of periodicities of visible waves, observers have found the dimensions of the predominant waves to be approximately related to the average wind-speeds. Using Cornish's observations recorded in Table I (Part II), for instance, the wind-speed/wave-period relationship conforms to a straight-line law, as in curve A of Fig. 7, to which two extraneous observations (one by Barber[1] and the other by the writer) accord very satisfactorily. Curve B in Fig. 7 is a marginal relationship linking **maximum** wave periodicity with wind-speed, as interpreted by the author from limited data given by Barber and Ursell.[2] The discontinuity in this relationship is curious, but is probably more apparent than real, for it is likely that the correct limiting relationship follows the trend of curve C. This implies that at wind-velocities above about 50 m.p.h. there is no longer any restriction on the maximum periodicity that sea-waves may have, and the inference is, therefore, that although the predominant visible waves at high winds will have periods in accordance with curve A, there is every chance of long invisible ground-swells being in existence at the same time.

The very obvious periodicities of several minutes that have often been detected in the wind-velocity of the air-currents advancing directly from the open sea upon Cape Town (cf. Fig. 5) would seem to be in evidence in favour of the supposition already made regarding a joint state of oscillation between air and water, resulting from wind-traction on the surface.

It is therefore probable that near storm-centres, where geostrophic wind-speeds are high and barometric fluctuations could exist on their own account, varying pressure on the sea from air oscillations becomes an additional factor to that of wind-traction in the generation of waves of all periodicities, but notably long-period ones. The "wind-blurring" of the microbarogram during high winds, mentioned in Part III (p. 109) supports this contention.

That a periodically-varying stationary surface-pressure applied to the free surface of the ocean will develop a series of expanding waves has been shown theoretically by Kelvin.[3] The initial and subsequent configurations of these waves will be much the same as those of a series of waves deriving from an initial group of equal sinusoidal displacements of the surface of the sea. Fig. 8, which is reproduced from Kelvin's paper, shows the profile of the sea-surface at zero-time and twice subsequently after equal intervals of time under these conditions.

The initial displacements divide up into two groups (in the plane problem) of progressive waves which separate and expand outwards. Points A on the diagrams of Fig. 8 travel at the full wave-velocity corresponding to the individual waves, while points B travel at only half the wave-velocity. It is clear therefore that the bulk of the waves advance at the group-velocity, while long attenuating waves, or ground-swells, precede the groups. Apparently, perceptible wave-disturbance runs ahead of points A at speeds greater than the wave velocity, and becomes more important in relation to the groups with advance of time.

In the more general case of an air-wave or line-pressure, such as a cold front or squall-line of a depression, advancing over the surface of the sea, theory again shows that there will be set up a train of water-waves, following in the wake of the line-pressure.

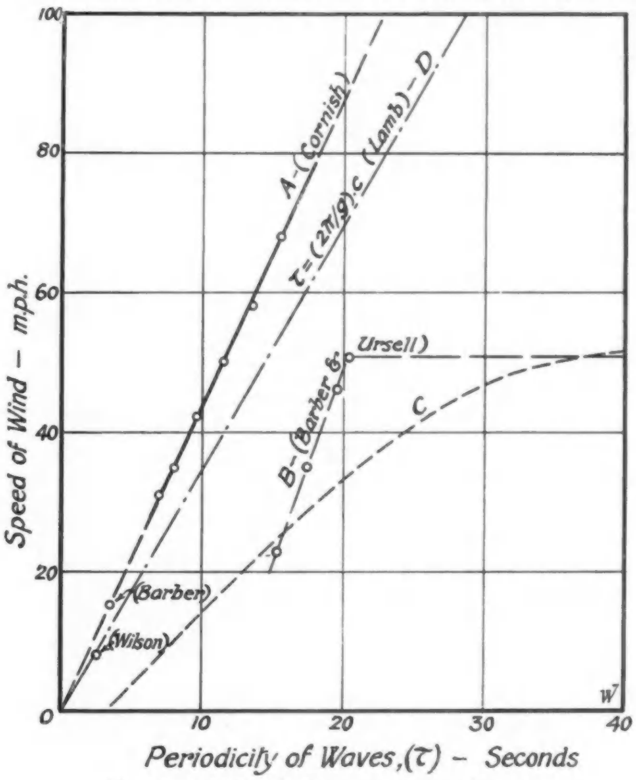
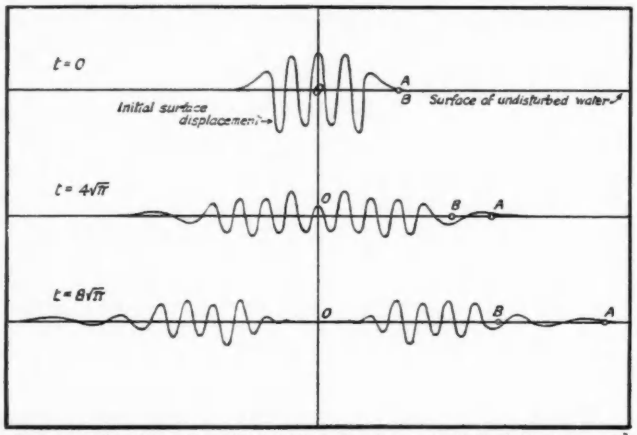


Fig. 7. Relationship between wind and wave.

The problem has been treated by Lamb[4] by considering, in the first instance, the train of standing waves that occurs on the down-stream side of a stationary concentrated line-pressure, acting on the surface of a stream of water of velocity C. By the mathematical device of impressing upon everything a velocity $-C$ in the same direction, Lamb showed that the effect of a travelling line-pressure, advancing with velocity C over still water, would be to generate a series of following waves of wave-length $\lambda = 2\pi C^2/g$ whose amplitudes would diminish with distance according to hyperbolic law. The periodicity of the waves would be $\tau = \left(\frac{2\pi}{g}\right) c$, and this equation, plotted in Fig. 7, yields the curve D, which is seen to correspond fairly closely with the empirical relationship A

Oscillations of the Sea and the Phenomenon of Range—continued



Reproduced from Kelvin's Paper No 39; Math. & Phys. Papers. Vol. IV, (Cambridge), 1910.

Fig. 8. Emanation of waves from an initial sinusoidal undulation of the sea.

derived from the observations of Cornish. This suggests that the mechanism of wave-generation by wind is the same in essence as that by a pressure disturbance advancing with the velocity of the wind. The two cases obviously merge when wind-gusts become strong enough to produce identifiable changes of pressure.

In the case of a series of pressure pulsations (air-waves, say) advancing over still water with velocity C, Lamb shows mathematically that a wave-train with a group-velocity U will be set up by the travelling disturbance, and will precede or follow it according to whether U is greater or less than C.

It seems clear therefore that pressure-variations on the surface of the sea are also to be reckoned with as agencies capable of activating ocean-waves of all types.

Vaughan Cornish, whose painstaking observations of ocean waves have already been referred to, describes how on one occasion a band of black cloud overtook his ship when the sea was slight and the wind had dropped.[5] Notwithstanding the fact that only a slight breath of wind accompanied the cloud, the sea was suddenly agitated by a heavy swell. The cloud passed in five minutes and in ten minutes the swell had gone. The inference here is that the swell accompanying the cloud was the direct result of an atmospheric pressure-disturbance.

What must have been a very remarkable instance of the same sort of thing occurred on January 13th, 1948, in the North Atlantic north-east of New York. "Death" waves, reputed to be 40-ft. high delayed such large ships as the *Queen Mary*, *Media* and *America* on the North Atlantic run. Commodore Manning of the *America* (26,300 tons) is reported to have said of this phenomenon:[6]

"About midnight on Tuesday (January 13th) when I thought myself out of the worst of the weather—there had been a series of intermittent gales all the way from the Irish coast—the barometer dropped suddenly. The weather became warmer. The wind dropped—it was blowing only a few miles an hour, but I found myself in huge seas. The ship was lashed from all sides. It was a violent movement of the entire ocean.

"I reckoned later that this condition covered an area of 600 or 700 miles. I went through it for 12 hours. It was most mysterious. I couldn't understand it—to see such seas with no wind. I had a most depressed feeling at the very experience. Waves usually curl and fall away, but these had no spray."

The *America*, which was crossing the North Atlantic from the British Isles, bound for New York, would have been head-on to the gales and presumably head-on to the swell following in the wake of the barometric disturbance, to which Manning refers. This disturbance must have been very remarkable and unusual to have affected so large an extent of ocean, and it would not be surprising if microbarographic fluctuations had been very much in evidence during the whole period of transit of the waves.

The Front and Rear of a Free Procession of Waves in Deep Water.

A large proportion of the waves reaching a coastline are swells which have escaped wind domination at their origins and have travelled the intervening distances of ocean against the vicissitudes of favourable or adverse currents in air and sea. Apart from any influences the latter may have, there will be changes in the initially finite group of waves consequent upon its expansion and propagation into regions of still water.

Kelvin posed and solved the hydrodynamical problem of what happens to a series of simple-harmonic water-waves when their initiating disturbance is withdrawn.[7] For this he adopted the ingenious method of considering a series of standing waves to the left or negative side of an assumed reference origin, O, as in Fig. 9 (a), which is reproduced from his paper. Thus at all great distances to the left of O there would be at zero time (t = 0) standing waves equivalent to the resultant of two equal trains of progressive waves moving in opposite directions. The rightward component-train would thus tend to invade smooth water to the right of O, while the leftward component-train would recede, leaving still water behind it.

The particular function used by Kelvin to represent the water surface at both front and rear in this way is shown in full-line in Fig. 9 (a): that of a true sine curve is shown in dash-line. The

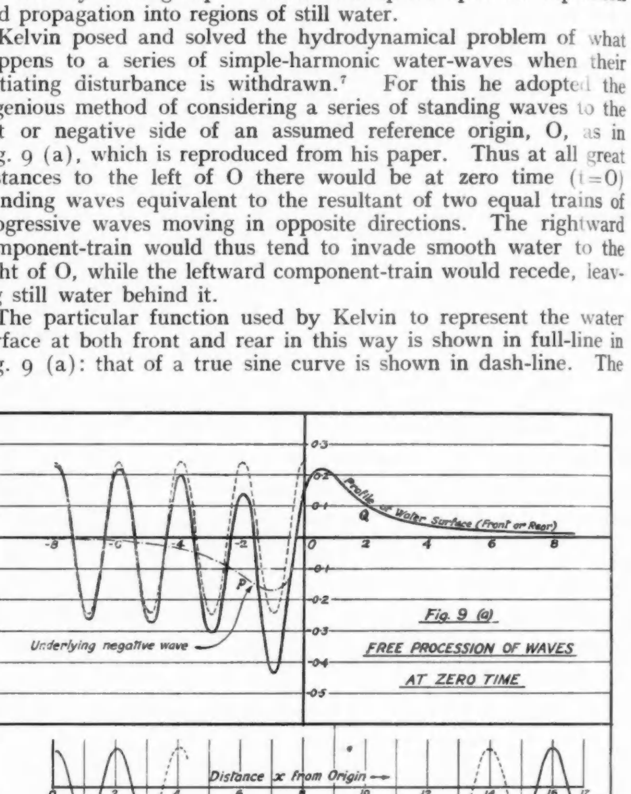


Fig. 9 (a) FREE PROCESSION OF WAVES AT ZERO TIME

Fig. 9 (b): FRONT OF WAVE PROCESSION, 25 WAVE-PERIODS AFTER ZERO TIME

Fig. 9 (c): REAR OF WAVE PROCESSION, 25 WAVE-PERIODS AFTER ZERO TIME

Main Features of the Diagrams reproduced from Kelvin's Paper (No 36), Math. & Phys. Papers, Vol. IV, (Cambridge, 1910)

Oscillations of the Sea and the Phenomenon of Range—continued

function becomes a true sine curve at about 4 wave-lengths to the left of the origin.

At a time equivalent to 25 wave-periods later ($t=25\tau$), the wave-front, advancing to the right, assumes the configuration shown in Fig. 9 (b). At the same time the rear of the procession will have distended to the configuration shown in Fig 9 (c), the latter being the reversed profile of a leftward movement of the tail-end wave-system shown in (a).

The diagrams show that after this particular lapse of time the front of the wave procession has advanced indefinitely with diminishing amplitude, even beyond the distance travelled by a point (A) at the full wave-velocity while the main body of undiminished sinusoidal waves lies behind a point (B), which has advanced from the origin at a speed of only half the wave-velocity. Point (C) in the rear of the procession has advanced at full wave-velocity; point (D) with half that velocity; the perceptible rear of the train is thus seen to be lagging about two wave-lengths behind a point advancing with only half the wave-velocity.

The inevitable result of the free movement of a wave-train into undisturbed water is a distension of the overall length of the group with lapse of time. The main group appears to advance at a speed of only half the wave-velocity with the rear lagging somewhat behind this rate of progression, while the front races ahead at speeds varying from half the wave-velocity to infinity. For all practical purposes, however, the important part of the wave-train lies between points which advance at the wave-velocity and half the wave-velocity.

A feature of very considerable interest in Fig. 9 (c) is the configuration of the rear of the wave-train, which is seen to exhibit what almost appear to be beat-characteristics. Upon residuating the main wave-train (Chrystal's method of eliminating harmonic components[8]) we find the residual dash-line profile of Fig. 9 (c), which can be further residuated by eliminating what seems to be a small-amplitude wave-train of the same periodicity as the parent-train but with a phase-difference of 90°. The final residual, shown in dash-dot line is found to correspond exactly with the inverted profile given in Kelvin's Fig. 7 (loc. cit.) for the case of a single push-pull wave at $t=25\tau$, and can be traced to the influence of the underlying push-pull wave $P-Q$ which is part of the assumed configuration of both the front and rear end of the original sinusoidal wave-train (Fig. 9 (a)).

Since any normal wave-train in water, as initially created, must have surfaces of continuity with still water, in front and rear, similar to those adopted by Kelvin at zero time, it follows that at any subsequent time the train of waves will be preceded by a series of long expanding waves, and will also be disturbed by the penetration through it from the rear of another series of smaller amplitude, ever-expanding long and short waves.

All this may shed new light on the fact, repeatedly observed at Cape Town and portrayed in Figs. 5 and 6, that the main body of the Range-disturbances (with maximum amplitude) is not only preceded by long waves but is also transfused by them. Here, too, possibly, lies the explanation to the conundrum, posed in Part II, that ground-swells have been observed to develop at a port after the lapse of winds and the abatement of a local storm. Kelvin's analysis shows that any swell that has passed out of the storm centre, and continues its propagation without restraint, will of its own accord tend to develop long waves which will be generally interspersed from the front to the rear of the main body of the swell.

Tidal Influence on Range-Action.

It was remarked earlier that Range-action at Cape Town shows a tendency to receive some slight stimulation from the state of the tide, being invariably of somewhat larger amplitude at the flood than at the ebb. There is actually an ever-present seiche between the breakwater and the shore, outside the harbour (Fig. 10), even in the calmest weather, making itself felt in a continuous rhythmic breathing of the water in the inner Alfred Basin. It would seem therefore that there is in the sea at all times an incessant, slow and minute change of level resulting from faint ground-swells arriving at the coast from far afield. These gain slightly in magnitude at the high tide. The effect is most noticeable in the

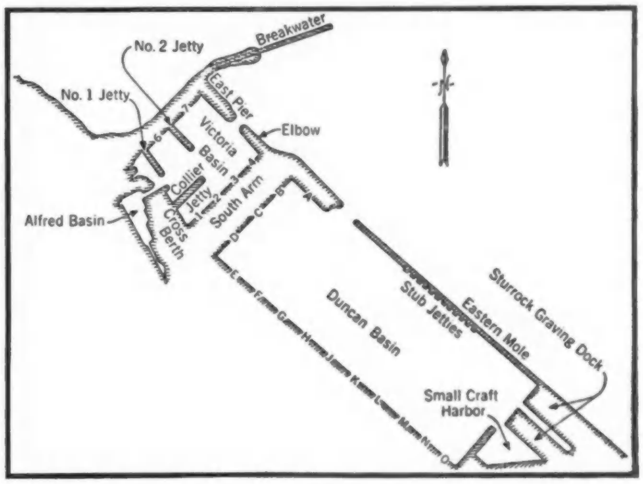


Fig. 10. Table Bay Harbour, Cape Town, 1945.

marigrams for the Duncan Basin, which are more particularly suited to the identification of the higher-frequency range. One finds that sometimes in fairly calm weather the marigram for this basin will exhibit a slight high-frequency embroidery at high water, which will be entirely absent at low water, and that this condition may repeat itself over several consecutive fluxes of the tide.

The obvious explanation which suggests itself is that weak swells, giving rise to this embroidery, are assisted in their propagation towards the coast by the favourable current of the in-running tide, whereas they are largely annulled when the tidal current reverses and draws off from the coast. That wave-energy can be much reduced or utterly destroyed by opposing tidal currents is well demonstrated by the turbulent "roosts" found in the sea channels separating Scotland, the Orkney and Shetland Islands.[9]

The fact that the embroidery (with weak swells) occurs only at slack water on the crest of the tidal wave and not on the rising tide itself, when the flux of water into the harbour is at its strongest, must be ascribed to the essential phase difference between tidal streams approaching the coast and those at the head of Table Bay.

Tides tend to co-oscillate by forming seiches where the typography of a coastline is favourable to resonance, as in the bay of Fundy, and this alters the phase of the tide in a bay in relation to what it is at the mouth.[10] Thus, in Table Bay slack water at high tide in the Duncan Basin will correspond with an influx of the tide outside the bay, where weak swells will be aided on their way to the coast; conversely, slack water at low tide at the head of the bay will be synchronous with an out-running tidal current off the coast, which will tend to destroy weak incoming swells.

(to be concluded)

REFERENCES

1 "Ocean Waves and Swell". Published Lecture. Maritime & Waterways Engg. Divn., Inst.C.E., 1950, p. 22.

2 "The Generation and Propagation of Ocean Waves and Swell", Phil. Trans. Roy. Soc. Lond., Vol. 240, 1948, pp. 527-560.

3 "Initiation of Deep Sea Waves of Three Classes", Math. & Phys. Papers (Cambridge), 1910, Vol. IV, Paper No. 39, pp. 419-456.

4 "Hydrodynamics" (Cambridge), 1932, Art. 243, pp. 400-402.

5 "Ocean Waves and Kindred Geophysical Phenomena" (Cambridge), 1934, pp. 9-10.

6 Press report, "Johannesburg Star", Jan. 16, 1948, and "Rand Daily Mail", Jan. 17, 1948.

7 "On the Front and Rear of a Free Procession of Waves in Deep Water", Vol. IV, Paper No. 36, pp. 351-367, 1910.

8 Chrystal, "Investigation of Seiches of Loch Earn by the Scottish Loch Survey, Trans. Roy. Soc. Edin., Vol. 45, Part II, 1906, pp. 382-387.

9 Cf. Rachel Carson, "The Sea Around Us" (London), 1951, p. 119.

10 Cf. Sverdrup, Johnson and Fleming, "The Oceans" (New York), 1942, p. 600.

New Hydraulics Research Station

Opening of Docks and Inland Waterways Laboratory

AT the opening ceremony* of the new Research Laboratory of the Docks and Inland Waterways Executive, Lord Hurcomb explained how the research organisations of each Executive came into being, and how their activities were co-ordinated by the Chief Research Officer of the Transport Commission. There can be no doubt about the continuation of the research work, which has been initiated by the various Executives, even though these Executives no longer enjoy an independent existence. There are certain activities of a large organisation, like the British Transport Commission, which must be divided functionally, and the research into applied hydraulics, already well under way in the new laboratory, will doubtless continue with the necessary degree of independence, despite the effect of re-organisation of the Transport Commission.

Lord Hurcomb spoke of the Commission's awareness of the necessity to devote considerable effort to research and development, both by work in the laboratory and in the field, over a wide range of subjects. "We have now reached," said Lord Hurcomb, "the stage where more attention can be given to long-term investigations likely to yield substantial results. We may not be able to forsee precisely what these results will be or at what point in time they will begin to return a worth-while dividend, but we are confident that the future of our undertaking depends largely on a bold and forward-looking policy for scientific research and development. The wide scope and variety of our many technical departments should be a great help to us by stimulating a kind of cross-fertilisation between our different forms of transport. If we can use radar to guide our ships it is only natural that we should be trying to find a way of applying these new aids to the movement of wagons in marshalling yards, in which fogs occur just as they do at sea. The establishment of a co-ordinating centre for all our research will bring these scattered activities together so that each may benefit from the thought and experience of the others. And there will gradually be created, in all branches of our undertaking, an increasing awareness of the value of scientific methods in transport, pervading research-mindedness, that will make it possible for the benefits of scientific exploration and enquiry to be reaped more quickly."

These remarks were made at a time when informed opinion was expressing anxiety about the relatively small proportion of national income which is being currently spent on research and development in Great Britain. This anxiety had been aroused by the latest report of the Advisory Council on Scientific Policy (1952-53),† from which it is clear that British industrial concerns not only spend less than their American counterparts, in relation to output, but, in addition, get less or later benefit from what they spend than they might. There are no accurate figures available for comparison beween Britain and the United States, but it is considered that, overall, both countries devote something under one per cent. of their national product to research. Making allowance for the differences in cost, it is estimated that Britain is perhaps producing about one quarter the volume of research compared with America. But, in Great Britain, a substantial majority of the research is Government sponsored, through Research Associations and the Ministry of Supply and the Admiralty, with an insufficient proportion taking place in industrial enterprises, into which latter category (rather than as a Government body) nationalised industry rightly falls. One of the reasons for inade-

*Docks and Inland Waterways Research Laboratory, Southall, Middx., opened formally on July 17, 1953.

†Her Majesty's Stationery Office, Card 8874, Price 6d.

Fig. 1. General view of the interior of the new Hydraulics Research Laboratory, showing model to investigate silting of a waterway in the foreground, a barge testing tank on the right, thermo-hydraulic research apparatus on left, and the wave tank used for experiments upon pneumatic breakwaters at the rear.

New Hydraulics Research Station—continued

quate investment in research cited in this report is the familiar one about the lack of capital investment in British industry at present. Transport has certainly suffered badly as a result of starvation of resources for capital equipment, and might not unreasonably have adopted an extremely cautious policy towards research expenditure. That this has not been so, and that a virile research organisation is in being, is greatly to the credit of all concerned.

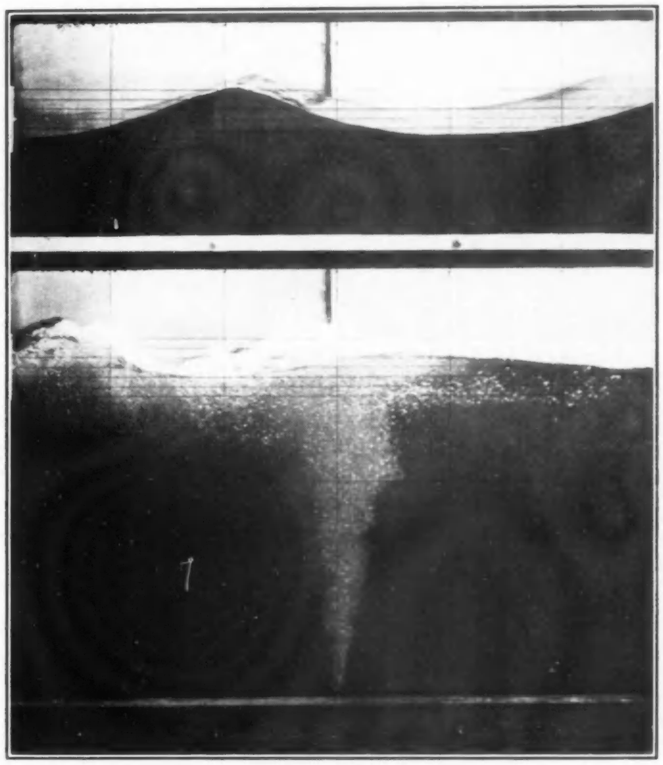


Fig. 2. Wave Tank, showing (above) a 4-ft. wave, and (below) the damping effect of the pneumatic breakwater. Note the turbulence on left and the reduction of waves on right.

The Docks and Waterways Research Department.

The Research Department of the Executive was set up in January 1950 to initiate and direct research on the problems of the Executive either directly or in conjunction with the Research Departments of other Executives or with outside bodies.

Under the direction of J. T. Evans, Esq., O.B.E., B.Sc. (Eng.), M.I.C.E., a hydraulic research laboratory has been designed and constructed in which the problems in hydraulic engineering characteristic of the work of the Executive may be tackled directly. The first section of this building was completed in October 1952. It is 126-ft. long by 45-ft. wide. The plan of

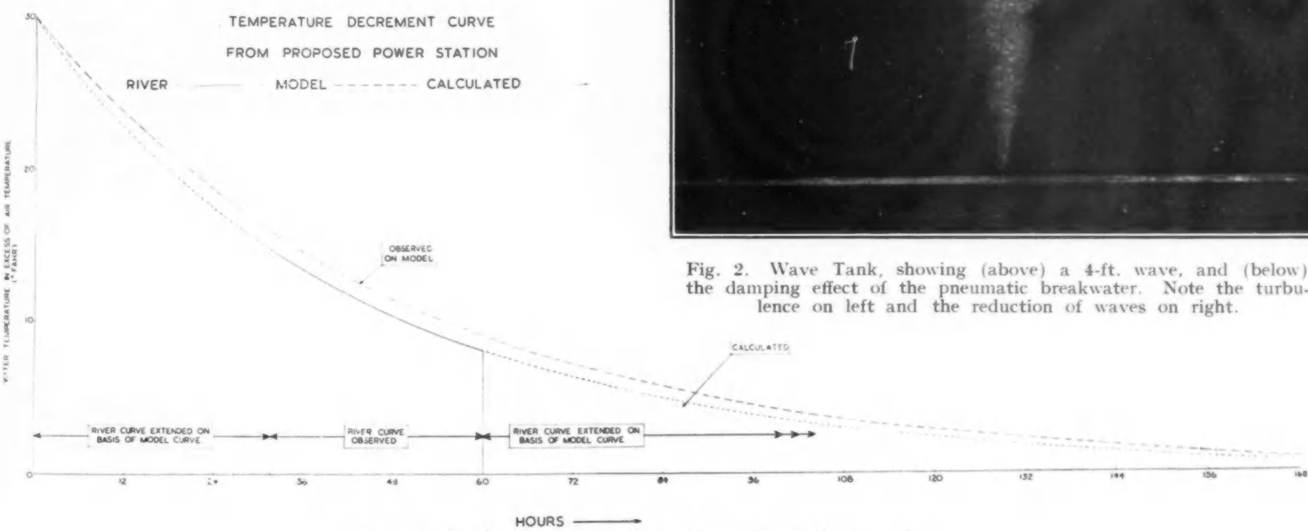


Fig. 3. Graphs showing results of thermo-hydraulic research.

the complete building includes additional laboratory space and office accommodation.

The experimental work to be undertaken in the hydraulic laboratory, is concerned with the design and improvement of works associated with flowing water in rivers, canals, docks and harbours; the prevention of scour and silting in dock and lock approaches, in estuaries and in rivers and canals; the elimination of cross currents; improved methods of lock operation and the design of sluices and sluice passages; faster lock and dock filling without undue turbulence; experiments on automatic sluices; a study of the energy contained in wash from different types of craft and its effect on bank protection; methods of damping or eliminating short steep waves; improved designs of craft; distribution of pollution in waterways.

Equipment now installed in the building and set to work includes a barge testing tank, a wave tank, and two hydraulic models of parts of rivers. The work proceeding on this equipment is typical of the investigations for which the laboratory is intended.

Fig. 1 shows the general arrangement of the laboratory, and shows clearly the extent of the apparatus at present installed and the possibility of accommodating more. No research station is ever able to proceed as rapidly as those concerned would like, and it would be no surprise to learn that progress here has been less rapid than it might have been, due to lack of staff or other resources. Unfortunately no published information about authorised research expenditure, in relation to turnover, appears to be available, and it is not therefore known what percentage the former bears to the latter. Be that as it may, the mere existence of this organisation is remarkable evidence of enterprise, which contrasts with the criticisms so often heard.

Although much of the work, some of which is described below, takes place in the laboratory itself, it is supplemented by measurements taken at the docks and on the waterways themselves, through the co-operation of the staff of these. Again, although the work is naturally directed towards objectives of value to the Transport Commission, it is not intended to adopt a narrow attitude, and papers given before the appropriate Professional Institutions will enable other undertakings to benefit from the Commission's work.

Barge Testing Tank.

The barge tank with its travelling dynamometer has been set up and adjusted to give the required accuracy in recording speed, tractive force, horse-power and wash. It represents a narrow canal and canal boats to the scale of 1-in. to a foot. The profile of the canal can readily be altered to represent other canals and various types of barge may be tested. At present, the channel is equivalent to one of 18-ft. bottom width and 4-ft. 6-in. depth, with sloping sides at 3 in 1 and piled banks.

The tank is to be used for seeking improved forms of craft. Improvements will be sought in larger carrying capacity, less drag through the water, less wash to erode the banks, improved methods of towing and new hull forms leading to simpler and

New Hydraulics Research Station—continued

cheaper construction. It is hoped that advance may be made in one or more of these directions.

Since working conditions on the narrow canals have changed so little in the last 150 years, this work is of great value. Much has still to be done; there is the matter of the effect of the screw of motor boats; there is the effect of mud and sediment at the canal bottom, for too few canals have a clear depth of 4-ft. 6-in.; there is the question of the nature of the wash created by empty motor canal boats. But, although the model is at present arranged to simulate a somewhat exceptionally dredged narrow canal, the problems of wider canals and larger craft are not being neglected; many of the factors involved are identical.

Wave Tank and Pneumatic Breakwater.

The wave tank installed is at present being used to investigate the fundamental reasons for the success, in some cases, and the failure in others of the device known as the Pneumatic Breakwater.* The wave tank itself is provided with a wave mechanism which can readily be adjusted to promote waves of various lengths and height. The experiments in progress are aimed at discovering the circumstances under which waves can successfully be eliminated by the release of air bubbles at the bottom. So far, it seems that within limits the size of the bubbles for a given air volume per foot length, has comparatively little effect upon the result; but, at this stage the officers of the Research Department do not consider that enough is known about the exact way in which the bubbles suppress the waves. That they do so in some cases is shown clearly in Fig. 2, where a wave is shown undamped, and, beneath, the same wave successfully broken up to create calm conditions beyond.

Excessive Silting at River Severn Lock.

At Bevere Lock on the River Severn the amount to be dredged each year from the upper approach is as much as that of the other four river locks put together. The hydraulic model represents about a mile of this part of the river to a horizontal scale of 1:120 to a mile, and a vertical scale of 1:40.

The relative water levels in different parts of the model and the height across the weir at different discharges accurately represent those observed and preliminary experiments are now proceeding to ensure that the rates of silt deposit in the different parts of the model correspond to those in the river.

It is hoped that experiments may throw light on the reasons for this excessive silting and hence on the best way to overcome it, without objectionable effects elsewhere.

Thermo-hydraulic Model.

Power stations and other industrial installations need a supply of cooling water, which can often be obtained from a canal or river; indeed this is frequently the reason for the siting of such works alongside a waterway, to the benefit of the coal and other traffic. However, the return to the canal of warmed water may so raise the temperature of the waterway as to cause a number of serious difficulties. The cooling water already being extracted at other points on the waterway may be increased in temperature enough to interfere with the functioning of plant; this is particularly likely in the case of refrigerating plant using large quantities of cooling water in the summer, due to the fact that a small rise in water temperature will have a marked adverse effect on performance; the warmed water may create fogs and prejudice traffic flow; the rise in temperature may be regarded as pollution, and at any proposed installation it is necessary to forecast to what temperature the water will rise, in order to decide whether the proposal is practicable at all.

In 1952, it was proposed to erect a power station whose operation would heat the waters of the River Calder and the Aire and Calder Canal. The Divisional Engineer asked the research Department to find out to what extent these harmful effects were likely to occur. The thermo-hydraulic model represents about a mile of this part of the river at the scale of 1:146 longitudinally, 1:118 transversely and 1:24 vertically. The model is so designed and adjusted that, other conditions being equal, the fall in temperature over a given distance on the model is the same as the fall in temperature for the corresponding distance on the waterway. It was found to yield results agreeing closely enough to the temperature changes observed in nature to give confidence in its accuracy. It was then operated in various conditions and the temperatures downstream obtained. Fig. 3 shows the results of the experiments, both those on the actual waterway, and those on the model. On the strength of model experiments over a wider range, it was possible reliably to calculate the temperature decrement, and to extend the waterway readings in the manner shown.

An interesting feature of the apparatus is the series of weirs and inverted weirs which are installed; in the waterway, the flow conditions are such as to create turbulent flow, but on the model, with the proper scale section and fall, the flow would be laminar, and this discrepancy would have threatened the reliability of the work. The weirs ensure turbulent flow and hence overcome the difficulty.

It is hoped that this work is typical of much more which will be achieved at this laboratory in the sense that no previous similar published work is known. The long-awaited re-organisation of British Transport must not be allowed to prejudice such worth-while experimental work. G.L.H.B.

*See article on "Pneumatic Breakwaters" by A. H. Laurie—Dock and Harbour Authority, May 1952. Also "Pneumatic Breakwater at Dover," December 1952.

Training of Dockers

Rotterdam's New Scheme

A new scheme for the training of dockers in the Port of Rotterdam is to be commenced in September, when the Dockers' Training School will start its first course. The scheme is a development from the training course started in 1949, under which about 1,500 men have received training, but it has been found that the results have not been completely satisfactory, as the choice of men for dock labour work has been rather limited, young candidates being an exception. The aim of the Dockers' Training School is to attract boys for work in the docks immediately they reach the age when school is no longer compulsory.

Boys entering the training school will take a course lasting two years, which will be followed by an apprenticeship of eighteen months. They can then take a final course, which will be the training now in existence for specialists and foremen. At the training school, entrance age for which is from 14½ to 16 years, one-third of the school time will be used for general education, one-third for work in the workshop and the remaining time for physical culture. No school fees will be charged and for productive work done during their second year in the workshop pupils will receive pocket-money. At the end of the course a certificate of mate will be issued. The boys will then work as apprentices in order to acquire the necessary practical knowledge in the various branches of the trade for which they are most suitable. They will be paid wages for the work they do during their apprenticeship, at the end of which period a certificate of journey-man will be issued.

The final course will train suitable mates and journeymen for the operation of mechanical apparatus (winches, lorries, machines, cranes, etc.), administrative and checking work (checkers, tally-men, gaugers, weighers, etc.), and responsible positions (hatch-foremen, foremen checkers, wharfingers, foremen, etc.).

The present training scheme is run under the auspices of an advisory committee of the Scheepvaart Vereeniging Zuid, in consultation with Professor F. J. Th. Rutten. A charter is to be given to this committee, in which employers as well as trade unions are represented, to continue with the new scheme. Both the Government and the Municipality of Rotterdam have given their approval and it is their intention to incorporate this training of dockers as from January 1 next in the Industrial School Act which implies that a subsidy will be given by the Ministry of Education (subject to approval of the Ministry of Finance) of 70 per cent., and a subsidy of 30 per cent. by the Municipality.

Repairs to Regents Canal Dock

New Technique in Dock Engineering

An interesting new development has recently been successfully carried out at the Docks and Inland Waterways Executive's Regent's Canal Dock in connection with the renewal of the outer ship lock gates which forms the sole outlet from the dock to the River Thames.

The work to be done on the lock itself in preparation for the new gates involved replacement of the gate pintles, dressing of granite quoins and renewal of timber sills with steel castings.

The dock has only one entrance, and it was important that the underwater work be carried out with a minimum of interference to shipping. Consideration was given to having the underwater work carried out by diver. This was discarded as it was considered that the setting of the pintles and sills to the existing granite which was known to be damaged, in water too heavily laden with silt to permit visual operation would be a protracted operation and the accuracy of the setting would be problematic.

The use of a half tide caisson dam was next examined. With shipping restricted to use of the lock for three hours at each tide, the dam could be used in the interim period. Allowing for positioning the dam, pumping out the lock chamber and removal, at the best two to three hours work between tides could be expected. After careful consideration it was thought that this method would be lengthy and too costly.

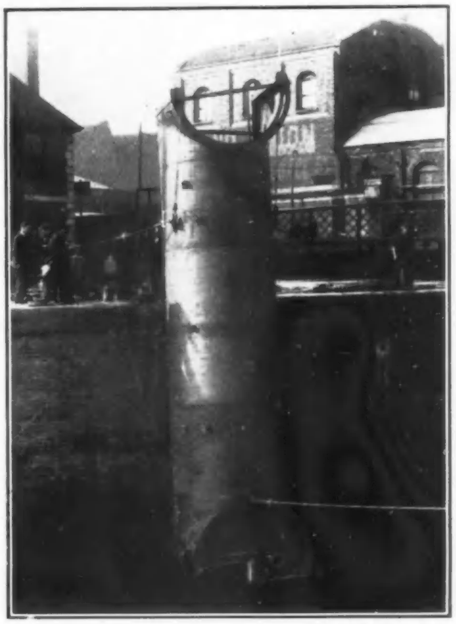
The work of dressing the quoins and setting the pintle could be carried out by the well tried method of a limpet dam placed against the wall of the lock and by working on one side at a time shipping could still pass. This still left the problem of setting the new sills, and as a solution an ingenious scheme was devised by the engineering staff of the South-Eastern Division of the Docks and Inland Waterways for the construction of an underwater tunnel using the limpet as the vertical shaft.

The idea was developed and a design produced, from which a scale model was made and tested out in a tank. The model showed that the idea was practicable and it was decided to proceed.

The limpet and tunnel were made of steel of semi-circular section 8-ft. in diameter in four pieces.

(1) The limpet with flanged connections top and bottom for permitting it to be used on either side of the lock and attaching the tunnel section.
(2) A straight tunnel section.
(3) A mitred section.
(4) An end plate shaped to the step of the sill.

The limpet and the tunnel were of welded construction consisting of a steel shell of $\frac{1}{4}$-in. plate suitably stiffened with transverse ribs and longitudinal bars; the stiffened shell being welded along the edges to 8-in. x 3-in. steel channels. Stiffened flanges were welded externally at the extremities of the shell for bolting the sections together. The steel work which had a total weight of only 14 tons was fabricated by Messrs. Towler & Sons of Stratford, London, E.

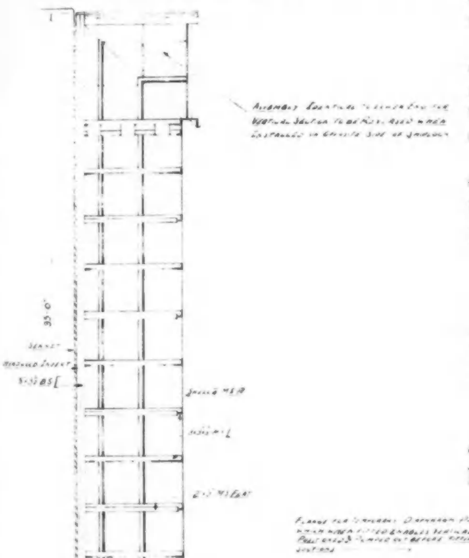


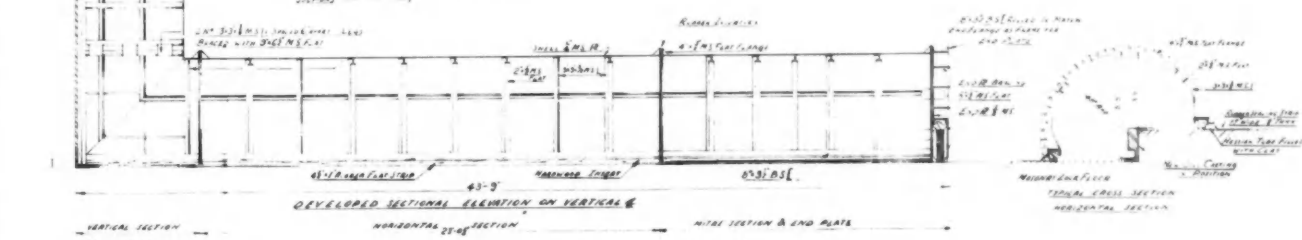
Limpet being lowered into position.

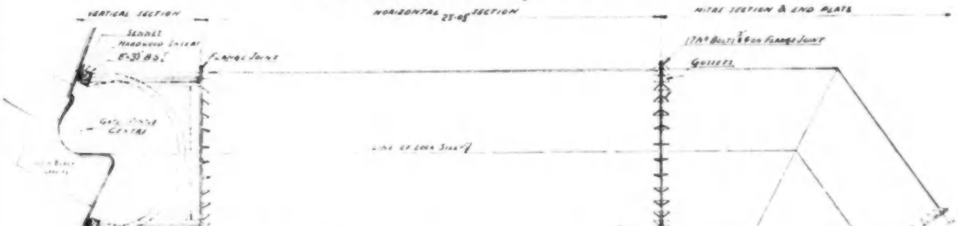
Oak timbers were fitted into the channels to carry the packings with which the joint between the limpet and the vertical wall of the lock in the one instance and between the tunnel and floor of the lock in the other were made.

The vertical joints were made with tallow dressed plaited spun yarn fastened to the timbers with canvas strips and the horizontal joints by $\frac{1}{2}$-in. rubber insertion bonded to the timber.

The joints between the steel sections were made with $\frac{1}{2}$-in. rubber insertion cemented



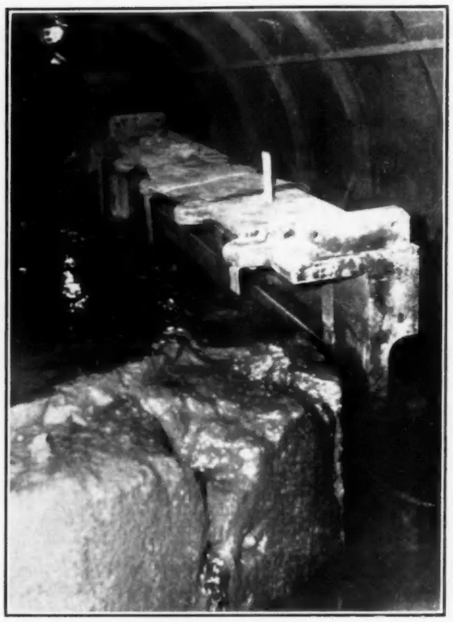




Plan and Sectional Elevation of Limpet Dam and Tunnel.

Repairs to Regents Canal Dock—continued

Mitre section being lowered into position.



View in tunnel taken from mitre showing existing granite, new sill castings and traveller for handling.

View in tunnel looking towards mitre showing new sill set in position.

to the steel flanges. The assembling and bolting up of the sections was carried out by divers.

The final scaling of the tunnel sections was effected by first placing close along the outside edges of the timber, "Sausages" 5-in. in diameter made of puddled clay sewn into double thickness hessian strips. Finally 18-in. wide strips of rubber insertion fastened to the outside of the oak timbers were laid over the "Sausages" and on to the lock floor.

The dewatering was effected by a 7-in. Sumo submersible pump and subsequent seepage was dealt with by means of a small hydraulic ejector.

Inside the tunnel a small travelling cradle with three dimensional movement was used to handle the sill castings. The working height in the tunnel was 5-ft. 6-in. and the work entailed no discomfort.

The limpet and tunnel being at atmospheric pressure with no air lock permitted unhampered movement within and the compressed air tools used for working inside prevented the air becoming foul.

A heavy fender of steel framing faced with timber bolted to the lock side was used to protect the limpet. The dock was able to continue in operation during the work subject to a draft restriction at certain states of the tide and depth of water over the top of tunnel varied from 28-ft. to 5-ft.

The civil engineering work including the placing of the limpet was carried out by Messrs. W. and C. French under the direction of the D. & I.W.E. engineers.

Comparisons in Port Working Methods

A Review of Recent Studies in Cargo Handling

(Specially Contributed)

During the past twelve months a number of informed articles and letters have been written on the ever controversial topic of relative port efficiency. These have included articles by Baudirektor Dr.-Ing. Hans Neumann, Chief Mechanical and Electrical Engineer, Port of Hamburg (this Journal June and July, 1952), "American Methods of Port Working. A review of International Opinion" (this Journal February and March, 1953), and letters to "The Dock and Harbour Authority" from A. D. Mackenzie, Chairman of the Melbourne Harbour Trust Commissioners, and F. W. E. Tydeman, General Manager, Port of Adelaide (April, 1953).

There has also been published a thoughtful article by J. Vasseur, Port Engineer, Havre, entitled "Diverse Conceptions sur L'Amenagement des Quais des Ports Maritimes" in "Navires Ports et Chantiers," June, 1952. An abridged translation of the main points of this article appeared in the July issue of this Journal.

The above list is no doubt incomplete, since the topic is one which is very much in the minds of Port Authorities and others concerned with the economical handling of merchandise. However, the facts and expressions of opinion contained in the contributions mentioned will serve as a nucleus for comment on some aspects of international port working.

The large number of variable factors in port working is responsible for a state of affairs in which it is possible, according to one's bias, to arrive at a variety of conclusions. One is reminded of the (fictitious) Cabinet Minister who said to his secretary, "I propose to make this statement in the House to-night; get me the statistics to prove it." This is not to suggest that frivolous conclusions have been reached by the writers whose labours are under review. On the contrary, the concept of what is most efficient, both in the mind of the port operator and that of the writer on port operation, is itself a product of something far more deep-seated than mere bias or prejudice. It has its roots in history, tradition, the economy of the country concerned (in which the degree of autarky is an important feature) and, as a product of these, in the degree to which the idea of public service in suitable spheres has ousted that of cut-throat competition by private enterprise.

Comparisons of port working tend, on the whole, to a confrontation of European with American methods, and, reading between the lines, one may gather that European operators are sufficiently in sympathy with each other's different methods (all having the same background and common purpose) to adopt collectively a critical attitude towards American methods. Doubtless the same attitude prevails on the other side of the Atlantic. The following story illustrates a common point of view. During the war, when the writer was in America, he was asked by a New Yorker, who tended to assume that all things European were perversely obsolete, "Why don't you English bring London up-to-date and save space by building skycrapers?" To which the writer replied, "Would you build skyscrapers on a river bank of clay which is floating on an artesian well?"

It is not until the subject is discussed in a spirit of mutual understanding that it is possible to arrive at an attitude in which it is

Comparisons in Port Working Methods—continued

no longer possible to say " This is better than that," but instead, " This is neither better than that, but only different, and for a good reason." Further, it is vital to bear in mind continuously that if we Europeans know what we are doing and why, we cannot concede any less to the Americans. The speed and vigour with which they have developed a continent is testimony enough to their vision and capability.

The writer does not presume to enter on a defence of American methods but rather attempts to show how the American way of handling port problems is bound to be the way it is, and how Americans are deeply committed by physical facts and economic actions in the past to a system of port working which is peculiar to that country and inevitable in its consequences.

American methods are different from those of Europe for the following reasons. The first is physical, and sets the pattern which tradition will perpetuate. It is the small rise and fall of tide in Atlantic and Gulf ports (while these were the first to be developed the same applies to Pacific ports). This fact alone has a profound influence from the start on the question of lifting gear. The second is also physical, with economic and political consequences. It is that the ratio of territory to coastline is very much larger than that of any western European country, so that America is not primarily a maritime nation. For the past 150 years Americans have faced westwards. The development of their vast territory has had the priority, and it is interesting to reflect that both North and South America were free to develop internally without fear of invasion in the 19th century by virtue of the policing of the Atlantic by the British Navy. Capital investment has tended to be away from the seaboard, and harbour development has been effected with minimum outlay.

The third reason is found in the history of American port development in the 19th century. In Europe, the pattern and channels of commerce were long established when railways arrived. Rail transport in Europe is essentially a substitution for older methods. In America, on the other hand, the history of that country's growth is the history of its railways. Without railways to span the vast distances, the country's economy would to this day be mainly agrarian, with a low standard of living. Ruthless competition between railroads resulted in the virtual extinction of inland waterways traffic, apart from the Great Lakes and Mississippi-Missouri-Ohio nexus, and in the appropriation of waterfront facilities by railway operators. Thus the growth of a rational utilisation of inland waterways was stifled in the larger activity of spanning the continent. A supplementary factor creeps in here, inasmuch as the climate compels the use of roofed freight cars. The loading of such cars is a matter for lateral movement of goods; the vertical element in crane handling is at a discount. While this is in itself not a sufficient reason for the absence of quayside cranes, it is one of the causes which contributes to the formation of a tradition, both in the absence of cranes and in the present vigorous use of mechanical aids at quay level, such as lift trucks.

The fourth reason is that America is not an importing and exporting nation, that is to say that her continued existence has not depended on overseas trading. This is particularly true of the period from 1830 to the present day, when America gradually opened up such a wealth of natural resources that to-day it is hard to think of any foreign commodity which is essential to America's well being except perhaps bauxite, coffee and natural rubber. Domestic commerce has provided Americans with bread and butter in good measure. Her foreign trade, excluding re-armament aid to Europe, has never been more than a small fraction of the total. It is natural therefore that Americans should not view port economics with the same intensity and seriousness as a European country which, failing seaborne trade, can be brought to hunger in a few weeks or months. This very natural attitude on the part of Americans is reflected in a sort of indifference regarding the efficiency of port operations. There is not the same urgency to handle exports and imports as cheaply as possible and this coupled with the other factors already mentioned has resulted in port methods in America which would spell disaster in Europe.

The fifth reason for difference in American port methods, is partly related to the fourth reason just given; it concerns the commercial and political climate prevailing at the time when many American ports took on their permanent layout. Whereas in Europe the ports in some form or another preceded the development of modern seaborne trade (which for the present purpose we may take as coinciding with steamships), in America it is broadly true that the ports in their present form grew simultaneously with steamships on the one hand and railways on the other.

Since, as has been mentioned above, America is not primarily a maritime nation the ports came into being relatively suddenly, and as ancillaries to the railways. They were in effect adaptations of railway stations at the water's edge, constructed by people who were mainly interested in railway operation, and without much interest in or experience of ships. Port development and such administration as existed were in the hands of private enterprise of a highly sectional kind, competition within the port is common even today, and Neumann mentions the existence of nine railroad companies in Hampton Roads, each operating its own port facilities.

Such uninhibited free enterprise, in which the interests of shipowners and shippers are not among the major considerations, has naturally led to the construction and equipping of ports as cheaply as possible, with the minimum outlay in equipment (except for specialised cargoes). This is in keeping with the development of America as a whole. The idea that certain activities affecting whole communities might better be administered by government agencies instead of by private enterprise is comparatively new in America; indeed such rapid expansion as has taken place could not have been brought to the pitch reached by the nineteen-thirties by anything but all-out private enterprise. Now, however, and dating from the Roosevelt administrations, there is a growing tendency in selected spheres of activity to engage in public works for the common good, and not for the sake of a sectional interest. No doubt port management will benefit in due course. By contrast European port management has for many years and in some instances, for centuries, been in the hands of committees or boards whose members were drawn from diverse mercantile and political interests. The point is that it is the administration or lack of it at the time when a port is planned and built which determines what accommodation shall be available. For example, the construction and dimensions of most American quays precludes now and for all time the installation of quayside cranes, whether or not today's operators wish to make use of them. Nothing short of reconstruction, strengthening, and widening will enable cranes to be installed and operated economically.

It is proper to say that the era of economic laissez-faire in America is giving way to something akin to the pattern of older countries. Readers of the article on the Port of Savannah (July 1953) will have observed that the port reached its peak of 4,000,000 short tons in 1908, suffered a decline, regained its peak again in 1938, and has only just, after the war, reached the same figure for the third time. That interested parties are now determined to put the port's fortunes on a stable footing with every promise of a steady increase in trade is shown by the integration of the Port Authority, Industrial Committee of Savannah and the Savannah Traffic Bureau into one State-chartered body, the Savannah District Authority, charged with the development and administration not only of the port but of local industry and traffic facilities. Port problems are thus likely to be treated with more breadth of vision, and with more regard for the many and varied users, than hitherto.

Mention should also be made of the statements made in the Productivity Report on Freight Handling of the Anglo-American Council on Productivity published in 1951, and quoted by Neumann to the effect that the Port of Boston is considering equipping two new quays with cargo cranes, though there is no mention of this in the article on Boston (" The Dock and Harbour Authority," February 1953), while New York is faced with a vast scheme of modernising its port facilities.

To sum up, American methods are the product of factors which are more deeply rooted than would at first appear. By the same token the methods and equipment of European ports is closely linked with Europe's geography, history and economics. Progress and improvements will doubtless be shown in both areas as and when new ports are constructed, for instance the greatly expanded transit sheds in new port works at Long Beach, California, or the improved width and surfacing of aprons in the reconstructed port of Rotterdam.

The above remarks apply mainly to the reasons why American methods of port working differ from those of Europe, insofar as

Comparisons in Port Working Methods—continued

capital investment in docks and equipment and general management policy are concerned.

A similar picture could be drawn of the human side of cargo handling. The relations between employers and labour, the rates of pay (whose apparent lavishness is mainly illusory, on account of the low purchasing power of the dollar in its own country), the employment of husky coloured dockers in many ports, working conditions, social insurance, and the impact of trades unions and racketeers—all these elements are part and parcel of the history and development of the country.

Without risk of oversimplification it may be said that so far as labour is concerned, each country is faced with different problems and each country works out the best answer for itself. Economic pressures and incentives will in the end bring about much the same output **per man hour,** for an equivalent cost, in the currency of that country. The question then immediately poses itself, " What use does the man make of machinery to increase his output?" The articles referred to contain a wealth of material on this topic.

Much has been made of the American workman's willingness to adopt and use mechanical aids. It is true that in American industry as a whole, the applied horse power available to aid the manual strength of each worker is higher than in Europe. This is to be expected because the large domestic market calls for an intensity of mass production which is seldom reached or required in European industries. In cargo handling on the other hand, it is doubtful whether American dockers use more aids than their opposite numbers in Europe. While they use more fork-lift trucks and other devices in which horizontal movement predominates over vertical, it is equally certain that the available horse-power per docker is vastly lower in America because of the lack of quayside cranes.

It follows then that the common belief of America as a mechanised Garden of Eden falls to the ground within the dock gates. Impressive figures of the output per gang unloading by ships' gear plus lift trucks, are basically deceptive. The data can be framed in such a way as to reflect great credit on the men employed, but there still remains unanswered the vital question of how many men there were, and following on from this question, how many men per hatch, and finally how many men, aided by how much horsepower **per ship.**

Neumann (page 42) has given some figures which because of their importance are worth quoting again in full. " Investigations in German ports as to the handling output of ships relying exclusively on their own gear have led to the following results:

(a) Hardly more than 50 per cent. of all present day ships dispose of sufficient booms as to be worked by more than five gangs.

(b) Even in the case of modern ships equipped with a larger number of booms, these are generally working to full handling capacity with five gangs, as part of the winches have to be employed for shifting cargo below deck.

" If quayside cranes are available for the handling of cargo the picture is as follows:

(a) If the ship and the hatches are large enough a number of up to 13 gangs may be working to the shore.

(b) In addition the ship can work simultaneously a further five gangs on the off-shore side into floating craft and still has available a sufficient number of winches for the shifting or stowage of cargo below the deck.

" The above figures agree with the practical experience that the loading and unloading of ships in European ports is performed **considerably faster** than in U.S.A. ports. Reports from ships' officers and port operators tell that, by the use of quayside cranes the handling output of a ship is increased by 50-70 per cent. as compared with the exclusive employment of ships' gear."

The emphasis is thus on the difference between ships' gear and cranes, and the human element is eliminated on both sides of the argument and the Atlantic. In other words, the best that a shipowner can hope for in an American port is a turn-round approximately 30 per cent. slower than he would secure in a European port.

McGillivray, in his address to the Institution of Naval Architects in March 1948 (" Speed at Sea and Despatch in Port " reprinted in " The Dock and Harbour Authority," May 1948), stated that in 1946-7 port charges and handling expenses constituted 51 per cent. of the total cost of operating a ship, excluding depreciation, and that this figure was divided as to 11 per cent. port charges and 40 per cent. handling expenses. It has often been pointed out, and rightly, that the proper function of a ship is to move across the sea. McGillivray's figures are for merchant shipping as a whole. While it is difficult to arrive at a comparative estimate of the cost of handling in Europe and America, there is no doubt at all that in America both the handling charges and the port charges, especially the latter, will in the case of ships trading with that country, represent an even higher percentage of the total operating cost.

In effect exports to America from Europe cost more to the importer, since the port charges, handling charges and ships' time have to be borne by the goods. Thus the slow turn-round in American ports constitutes an invisible, but none the less real, tariff barrier adding to the difficulties of European exporters competing in the American domestic market. Similarly American imports into Europe carry an extra burden.

Enough has been said in the earlier stages of this article to show that here is a situation which, despite recent attempts to improve port conditions in America, is deep rooted, and must in the main be accepted. If America were primarily an exporting country, relying on overseas trade to live, the picture might well be different. But so long as Europe's need for dollars is greater than America's needs in the opposite direction, and this seems likely to obtain indefinitely, it is unlikely that American standards of port equipment and management will approximate to those of European countries.

Marine Radar Developments

During the last few weeks, two demonstrations have been given in London showing notable advances in marine radar technique. On 11th August, Messrs. Kelvin and Hughes (Marine) Ltd. introduced to the shipping and technical press, their new long-range set known as Type 2C, and two weeks later, Messrs. Decca Radar Ltd. demonstrated their new 45 High Ratio Pulse Radar.

Kelvin and Hughes (Marine) Ltd.

Type 2C which costs about £2,200 is claimed to provide substantial advances in all round operational performance with no increase of initial or up-keep costs, and as the value of Marine Radar as a navigational aid is now well established, the most attractive feature of this new set is the long-range searcher scale which covers a 50 sea mile radius.

A high definition 12-in. P.P.I. Display is used in this new equipment, and a choice of four scale ranges is provided.

The short range is intended for working in the confined spaces of estuaries and other narrow channels. This range is continuously adjustable between the limits of one and five miles, so that the most useful intermediate scale for any set of conditions is instantly available.

The ten-mile range has been proved to be a most satisfactory scale for coastwise pilotage and for keeping a look-out when proceeding in poor visibility, and the 25 mile scale is for long-range detection of average targets.

The fourth is a 50 mile range searcher scale designed to assist position fixing. While radar detection is essentially limited to horizon range, experience has shown that there are many targets along the various trade routes which have suitable characteristics for detection at ranges longer than those hitherto achieved with standard radar equipment.

In designing this equipment the importance of reliability has been kept well in mind. The long detection range has been achieved by the simplest possible means, involving no complications which could adversely affect the reliability factor.

Decca Radar Ltd.

The Decca 45 High Ratio Pulse Radar has six effective ranges between $\frac{1}{2}$ mile and 45 miles and is designed to meet two conflicting operational requirements: firstly, to give the best possible performance at long range with solid pictures of distant landfalls, and secondly, to give the highest picture definition at short range for navigation in close congested waters. For the best performance at long range the radar pulse must be long, preferably 1.0

Marine Radar Developments—continued

microsecond, and for a crisp accurate picture at short range the pulse must be very short, preferably 0.1 microsecond. This problem has now been successfully solved by the development of High Ratio Pulsing. Thus in one radar set the hitherto unattainable combination of maximum efficiency at long range and highest quality of short range presentation has been achieved.

By raising the efficiency of the Type 12 set by 15 decibels, or the equivalent of 32 times, the long range of reception has been increased by a 1.5 factor. In consequence an object which was previously visible at 20 miles is now visible at 30 miles, while the maximum range is increased from 30 miles to 45 miles. The effective ranges of the set are ½, 1, 3, 10, 25 and 45 miles, and it is claimed that for the first time the exceptional scale of ½ mile has been presented on a 12-in. screen in a commercial marine radar set. Coupled with the high picture quality, this scale will be of great value for manœuvring in bad visibility in congested areas and confined waters.

The Decca 45 remains at the same size as the Type 12, and its scanner has been enlarged to provide a narrower and sharper beam; increased efficiency has also been achieved by technical improvements in various working parts. Another important feature is the provision of a true stand-by switch which cuts the supplies from the cathode ray tube and magnetron. At the touch of this switch, the navigating officer has his radar picture instantly without incurring wastage from full continuous radar use.

The price of the equipment, which has already been given Ministry of Transport Type approval, is £1,900 and production begins in quantity on 1st October next.

Manufacturers' Announcements

Aluminium Passenger Pontoons

Pontoons, designed and built by Whittingham & Mitchel Ltd., of Byfleet, Surrey, England, for use on the Orient Line vessels "Orcades" and "Oronsay," represent an interesting use of aluminium alloys for speeding-up the disembarkation of passengers on cruising ships at points of call where no harbour facilities exist, and where the operation has to be effected by ships' launches.

These pontoons can be considered as landing stages slung over the ships' side, 2-ft. above water level, and access to them is by means of the ships accommodation ladders. They weigh only 3,000 lbs., probably one-third of an equivalent steel equipment, so the saving is of great importance for easy handling, and makes possible more compact buoyancy tanks.

Demonstration of the new pontoon.

As the stations at which they operate present varying contours of the ship side, adjustable spurs are provided so that they can be firmly braced to the ship. Structurally, the pontoon is a box 20-ft. x 8-ft. x 6-ft. deep. The top side is very strong, comprising 5/16th thick P-P-G (Positive-Grip-Pattern) Treadplate suitably stiffened by deep beams and the edges riveted to a channel framing, which is protected by a substantial elm fender. It is this reinforced deck which provides the main resistance to impact from launches coming alongside.

The long sides of the pontoon are girders built from substantial T-section extrusions. Each bay, including the ends, is diagonally braced with similar sections. The bottom panel is again a channel frame, spaced with heavy gauge 3-in. diameter tubes, which transmit impact loads across this panel. Buoyancy is provided by six cylindrical tanks located immediately under the deck plating, all seams and diaphragms being welded by the Argon Arc process.

Most of the metal used in the production of these pontoons was supplied by the British Aluminium Company Ltd.

New Diesel Locomotive Erecting Shop

During the past few years there have been a number of extensions to the Castle Engine Works, Stafford, where Messrs. W. G. Bagnall, Ltd. have been building locomotives for close on eighty years. The locomotive erecting shop, where steam, fireless and diesel locomotives were erected side by side has, however, been a limiting factor in increasing output and the Board therefore decided that an entirely new erecting shop should be built to deal with the increasing demand for the firm's diesel locomotives. This shop has now been completed and brought into use.

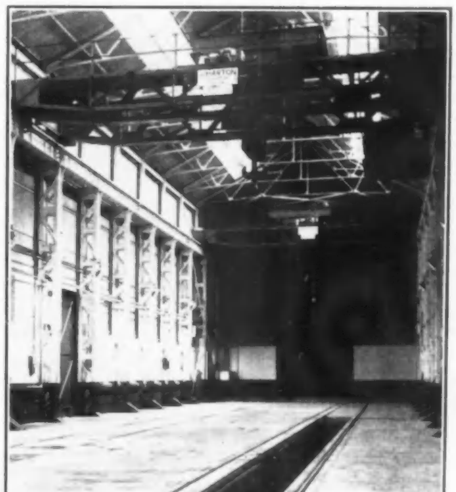
The new shop is of heavy steel construction carried on continuous reinforced concrete foundations. It measures 175-ft. by 43-ft. and is 40-ft. high at the eaves. Brick walls are carried up to a height of 11-ft. and the remainder of the building is sheeted with corrugated asbestos. Two tracks, running the full length of the shop, are set flush in the granolithic floor. One of these is of mixed gauge and provides for the construction of locomotives of 5-ft. 6-in., 4-ft. 8½-in., 3-ft. 6-in. and metre gauges.

Two electric, overhead travelling cranes, each of 50 tons lifting capacity, run the full length of the shop on a craneway 30-ft. above rail level. These are capable of lifting the heaviest locomotives and the headroom is such that one locomotive can be lifted clear over another on the same track.

The shop will be used for the erection of diesel mechanical locomotives to the firm's own design and of diesel electric locomotives designed and sold by Brush Bagnall Traction Limited—a joint company in which Messrs. Bagnalls are associated with the Brush Electrical Engineering Co. Ltd., of Loughborough.

Messrs. Elliott, Cox and Partners were the architects and Messrs. F. and E. V. Linford Ltd. the main contractors. Messrs. West Midlands Erection Ltd. were the steel work sub-contractors and Messrs. Wharton Crane and Hoist Ltd. supplied the 50-ton overhead crane.

The provision of this new diesel erecting shop, in conjunction with the installation of a large number of new machine tools in the machine shop, will enable the firm greatly to increase their output of diesel locomotives for which there is a steadily increasing demand.



The new Erecting Shop at Castle Engine Works.

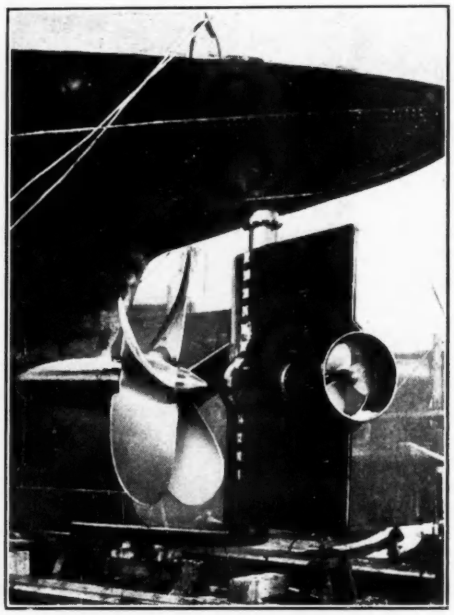
Manufacturers' Announcements—continued

The 'Pleuger' Active Rudder

A new steering device known as the "Active Rudder," which is claimed to have many advantages over the normal rudder, has recently been designed by a German company. The reaction of the normal or "passive" rudder is only induced by a current produced by the propeller or the ship's movement, but the new type of rudder is effective from a standstill and is able to turn the vessel on the spot or in very narrow circles. Such "active" rudder principles are already well known, as for instance in the Voith-Schneider propeller, or in the bevel gear-driven outboard propellers, e.g. the "Harbourmaster" or similar devices.

The "Active Rudder" is an electric motor driving a propeller; the unit is housed in a streamlined body and is either incorporated in the normal rudder body or is fixed directly to a rudder shaft. As the rudder shaft is turned the unit also turns, applying steering forces to the vessel's stern in the helm's angle. The system may be used with obvious advantages where the propeller diameter required for a single screw can be reduced by the use of several units of smaller propeller diameter, as for instance in shallow water, or where barges may be converted into self-propelled vessels without major alterations to the ship's hull, or where a vessel has to proceed at reduced speed and power for long periods, e.g., ferries, pilot ships, floating cranes, fishing trawlers, etc.

The most favourable application is for the improvement of steering properties. For this purpose, the propulsion effect of the "Active Rudder" is of minor importance, as the Rudder is only supplied with sufficient power to obtain the improved steering properties, whilst the main propulsion power is still installed for the main propeller shaft as usual. In such cases the reduced efficiency of the Active Rudder plant is negligible because its power is only a fraction of the total power required for propulsion. In its present state of development there is ample power for the manœuvring of large vessels, the motor size being limited to about 250-350 h.p.



View of the "Pleuger" active rudder.

Some of the advantages claimed for the "Active Rudder" are as follows:

(1) Full steering capacity at low or even no speed.
(2) Easy and safe manœuvring in narrow waters, harbours, docks and during fog, etc.
(3) Going astern with the same reliability and ease as going ahead.
(4) Safe and easy landings, etc.

All these advantages have been fully established on the trials and voyages of several vessels. The first "Active Rudder" was installed in a motor launch of the Harbour Police in Hamburg; two Rudder units of 35 SHP each were fitted to the stern of the boat, without a main propeller shaft. The launch has been in service continuously since 1950, and is still giving satisfaction; the last inspection of the motors revealed no faults or unusual wear of bearings or insulation.

The United Kingdom Agents are Messrs. Meredith and Co. of Coleshill, Birmingham.

New Appliance for Grab Dre ging

In a new publication, Priestman Bros., Ltd., give an illustrated description f what are termed "under water eyes." The appliance consists of two dials which enable a crane driver to accurately cont ol the operation of a grab when submer ed beneath the water.

One dial is a slewing indicator, and the other indicates the depth of working. The former shows the driver the radial location of the jib in relation to the centre line of the vessel, and also indicates to him the position from which the last bite was taken. The depth indicator enables the driver to dredge to a constant, predetermined depth, and thus avoid the digging of holes and dredging below the desired level. This dial also shows the driver whether the grab jaws are open, or partially open, before they commence to close, thus presenting the jaws to the material in the best digging position.

The use of the new appliance is claimed to lead to economically accurate pattern dredging, and the maximum number of full grab loads, resulting in a level bottom being achieved. One of the interesting items in the use of the latest types of the Priestman grab is the level surface of the spoil material when brought to the surface, which indicates that each "bite" taken leaves a clear cut on the bottom.

This publication contains illustrations of various types of grab dredgers working in different parts of the world, and gives particulars of standard sizes of dredging cranes.

Cuban Port Booklet

Messrs. R. Diaz and Co., Lonja Building, P.O. Box 2258, Havana, Cuba, announce that the latest issue of their booklet, "Tariffs and Regulations of all Cuban Ports," is now available, and that they will be glad to provide anyone interested with copies. The booklet contains complete information concerning port charges, stevedoring, taxes, etc., also official regulations. Holders of the booklet are informed by air mail of any changes in regulations and charges, so that the contents may always be kept up to date.